Terra SRBAVG Ed2D: Validation/Status

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Outline

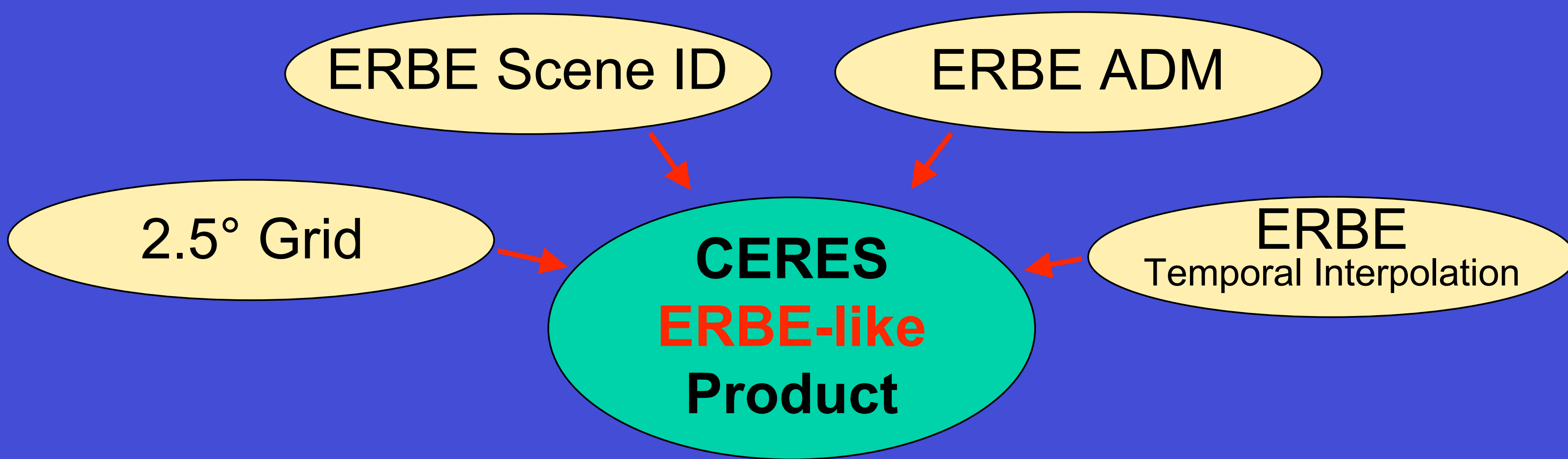
- Globally Gridded CERES Time in Space Averaged (TISA) Products
  - What CERES monthly gridded products are available?
  - Order at http://eosweb.larc.nasa.gov/ under CERES
  - How do I know which one is best for my research?
- CERES Temporal Interpolation - latest release uses geostationary data between CERES observations
  - Must produce climate quality monthly mean fluxes that maintain the CERES instrument calibration
  - How successfully do we remove temporal sampling errors?
- Comparison of CERES global fluxes with other datasets
  - How do the CERES gridded TOA product fluxes and cloud forcing compare?

CERES Monthly Gridded Products

- CERES products
  - Regional radiative fluxes and cloud properties at TOA, surface and profile levels
- There are 4 main CERES product groups
  - ERBE-like
    - Uses ERBE algorithms to derive fluxes
  - SRBAVG Non-GEO
    - Uses the CERES ADMs to derive fluxes
  - SRBAVG GEO
    - Adds geostationary fluxes to improve temporal sampling
  - SYN/AVG/ZAVG
    - Produces global synoptic maps and radiative transfer fluxes

ERBE-like Product

- Product Features:
  - – Based on ERBE algorithms and in the same format (ES-4 & ES-9) as the original ERBE scanner dataset (1985-1989)



- Appropriate Usage:
  - – To compare with historical ERBE (1985-1989) fluxes to ensure that flux differences are not associated with CERES algorithm improvements

Current Editions of ERBE-like

Edition 1

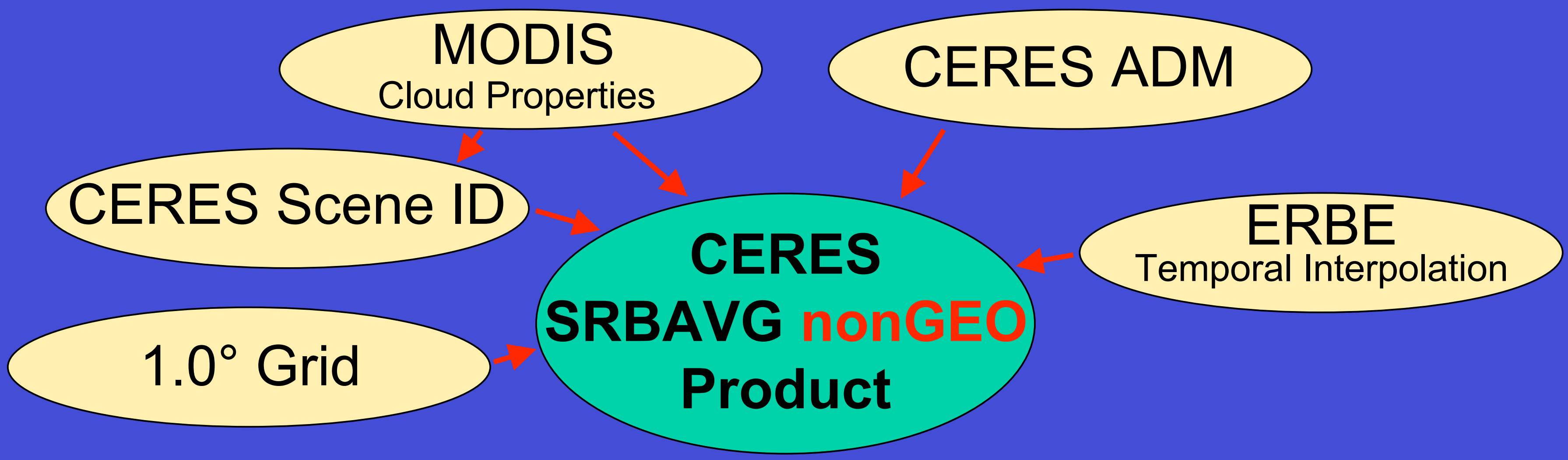
- First look at CERES fluxes
- Usually available within 2 months
- No on orbit calibration corrections
- Use with caution

Edition 2

- Contains on orbit calibration corrections
- Compare with ERBE

SRBAVG nonGEO Product

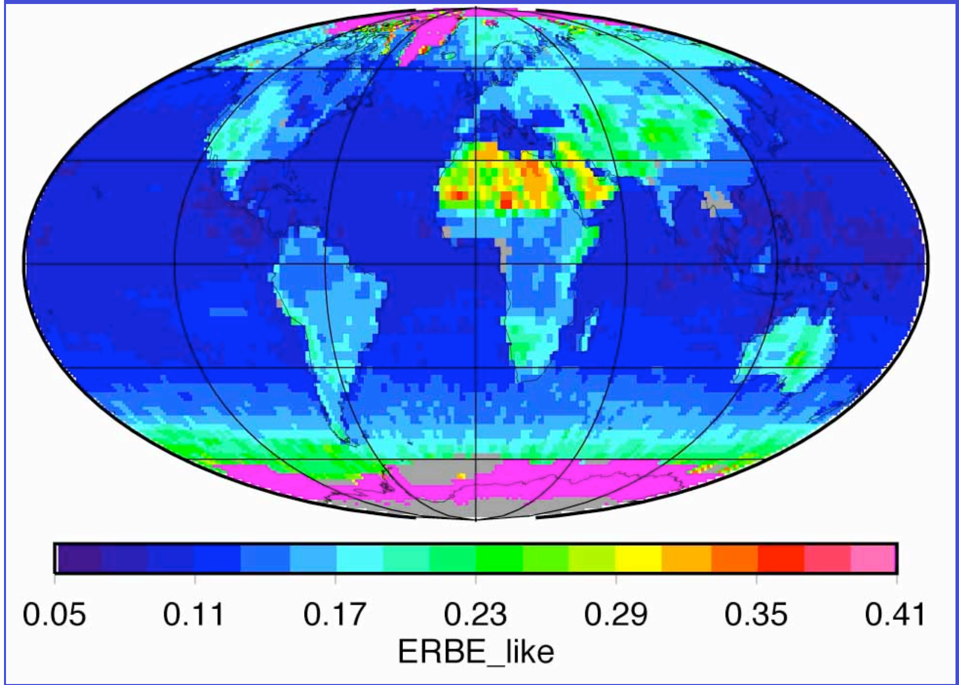
- Product Features:
  - TOA fluxes and MODIS cloud properties



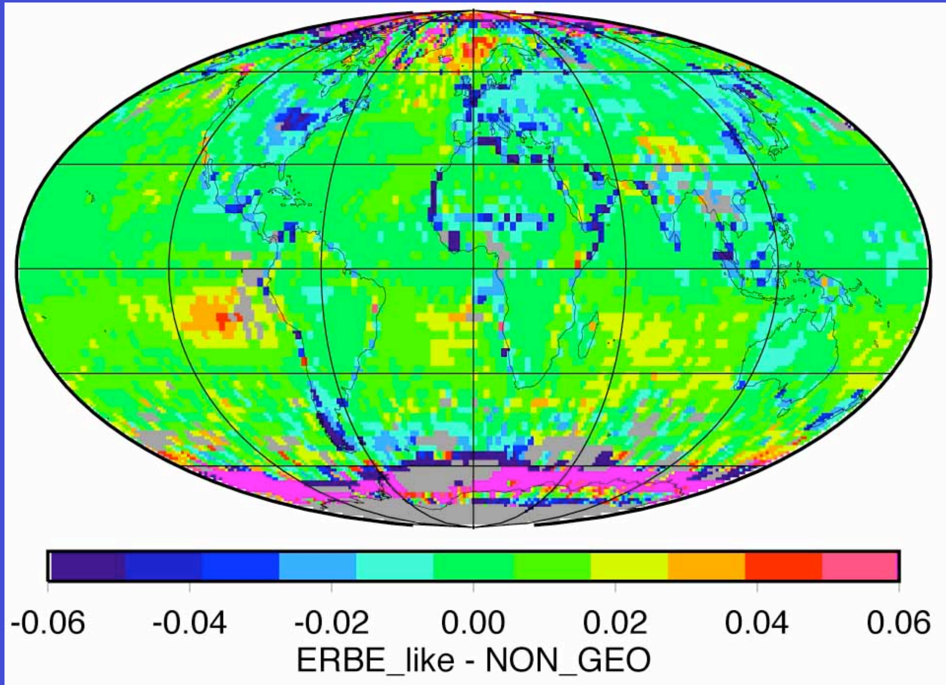
- Appropriate Usage:
  - To evaluate CERES ADM improvements
  - Fluxes and cloud properties are sampled only during Terra overpasses

Aug 2002 Clear-sky Albedo

ERBE like mean



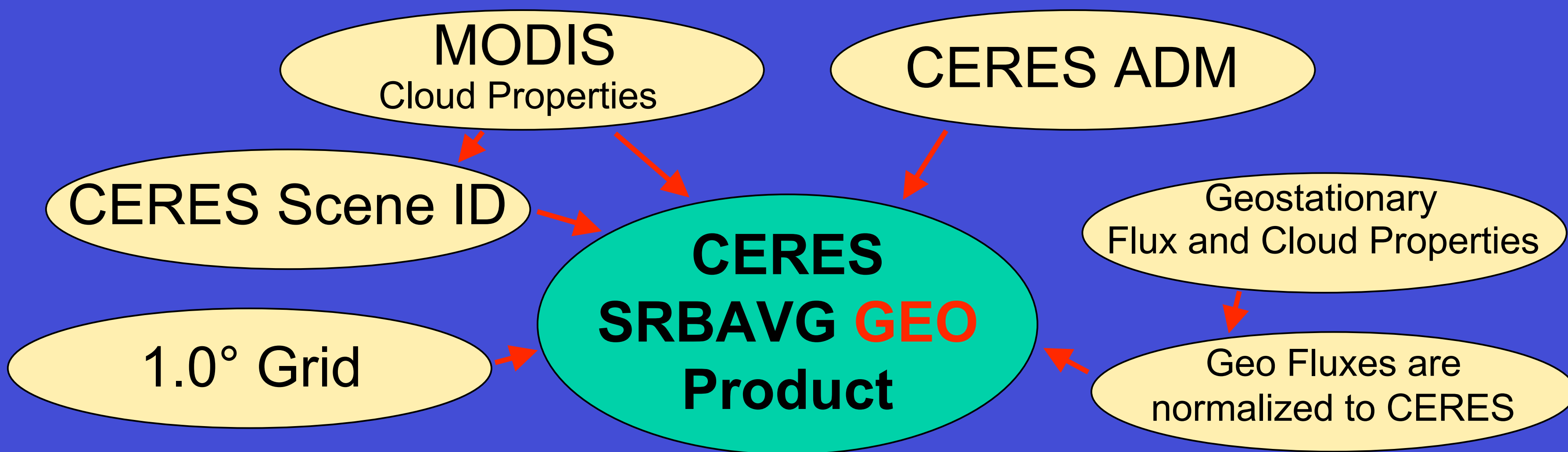
ERBE like - nonGEO



- The CERES ADMs and scene identification is an improvement over ERBE-like
  - most notable in clear-sky identification
- This will effect cloud forcing fluxes

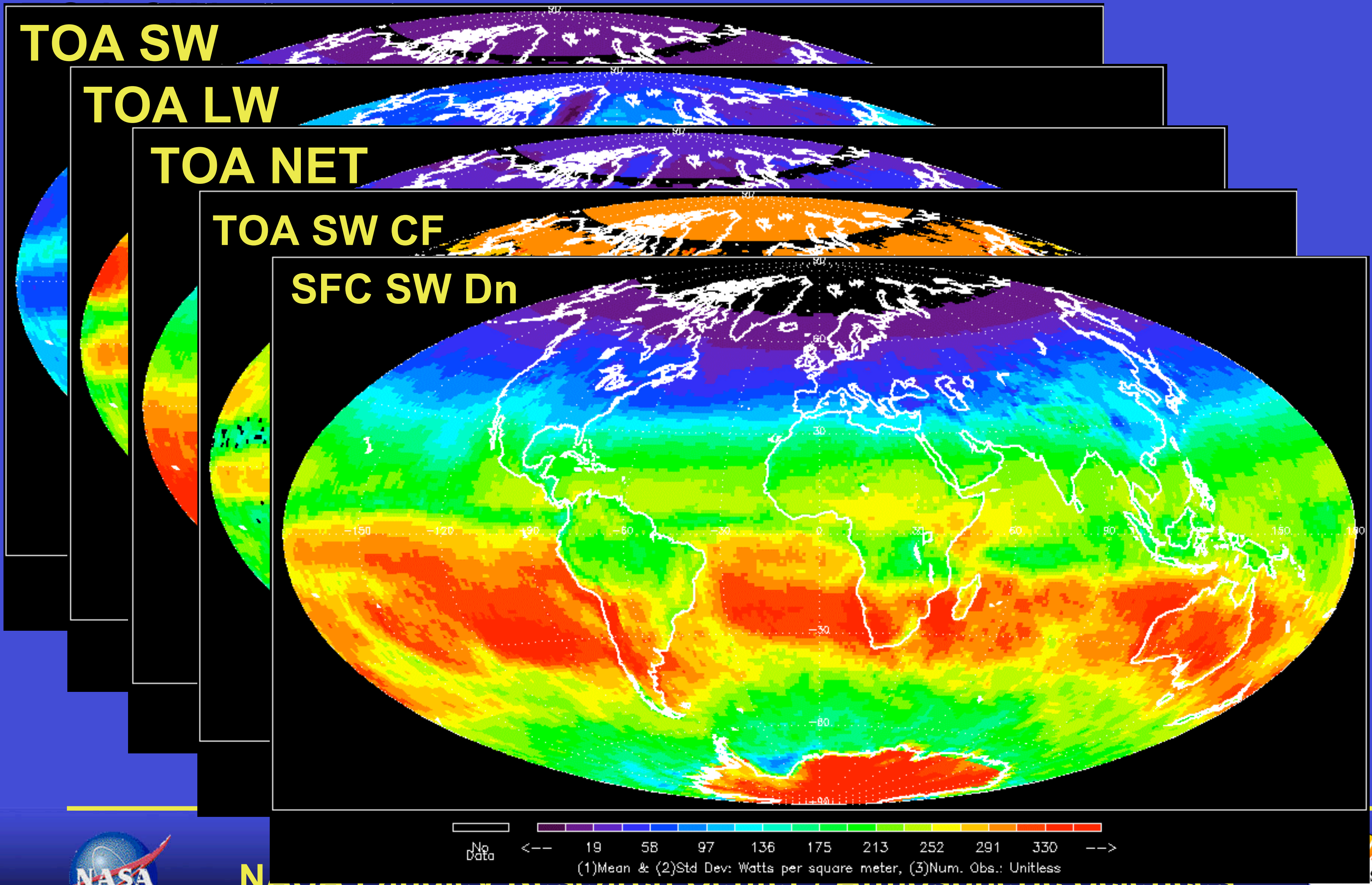
SRBAVG GEO Product

- Product Features:
  - TOA and surface fluxes and MODIS/GEO cloud properties
  - Uses 3-hourly geostationary derived fluxes and cloud properties to interpolate between CERES observations

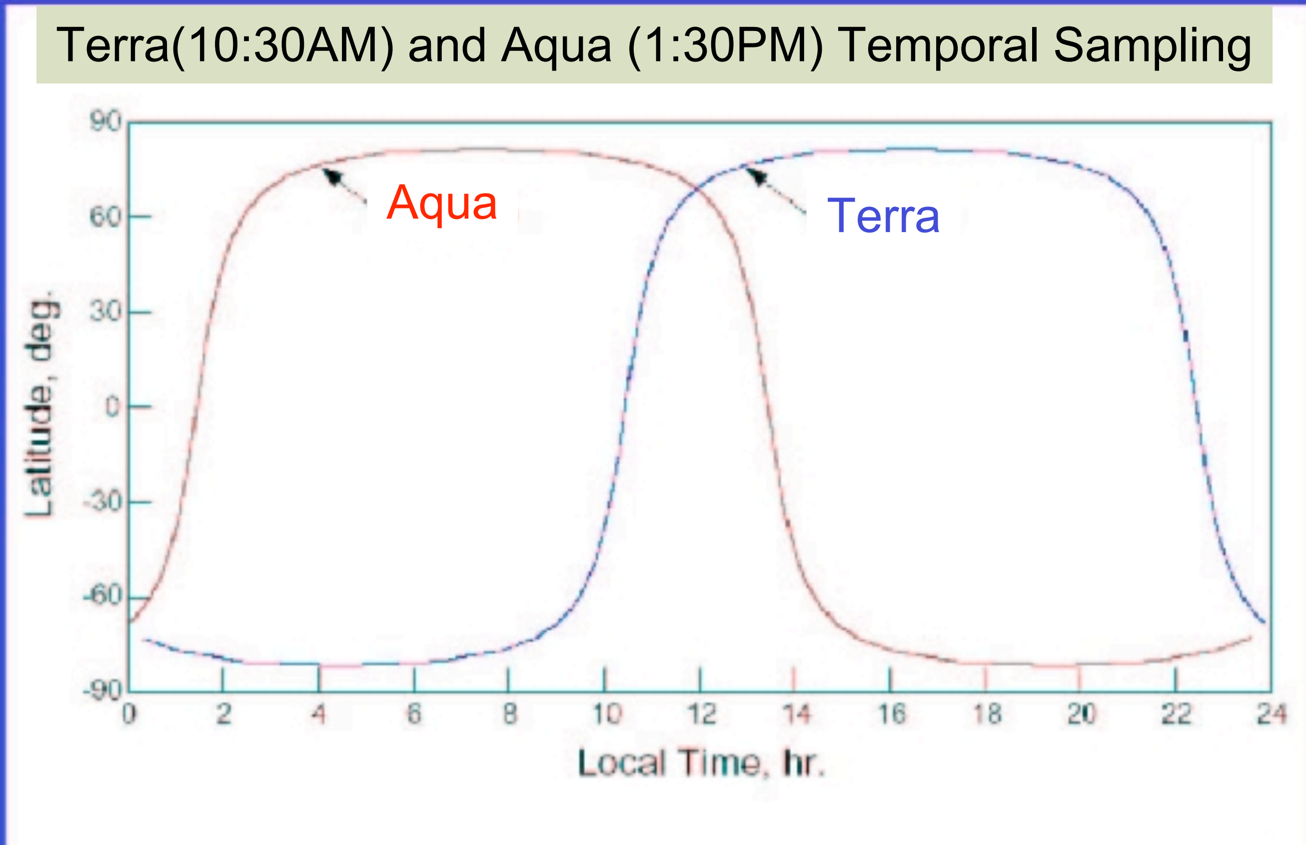


- Appropriate Usage:
  - The SRBAVG GEO product is the most robust CERES TOA monthly mean flux product and of climate quality

SRBAVG-GEO Monthly Gridded Products
Jan 2002



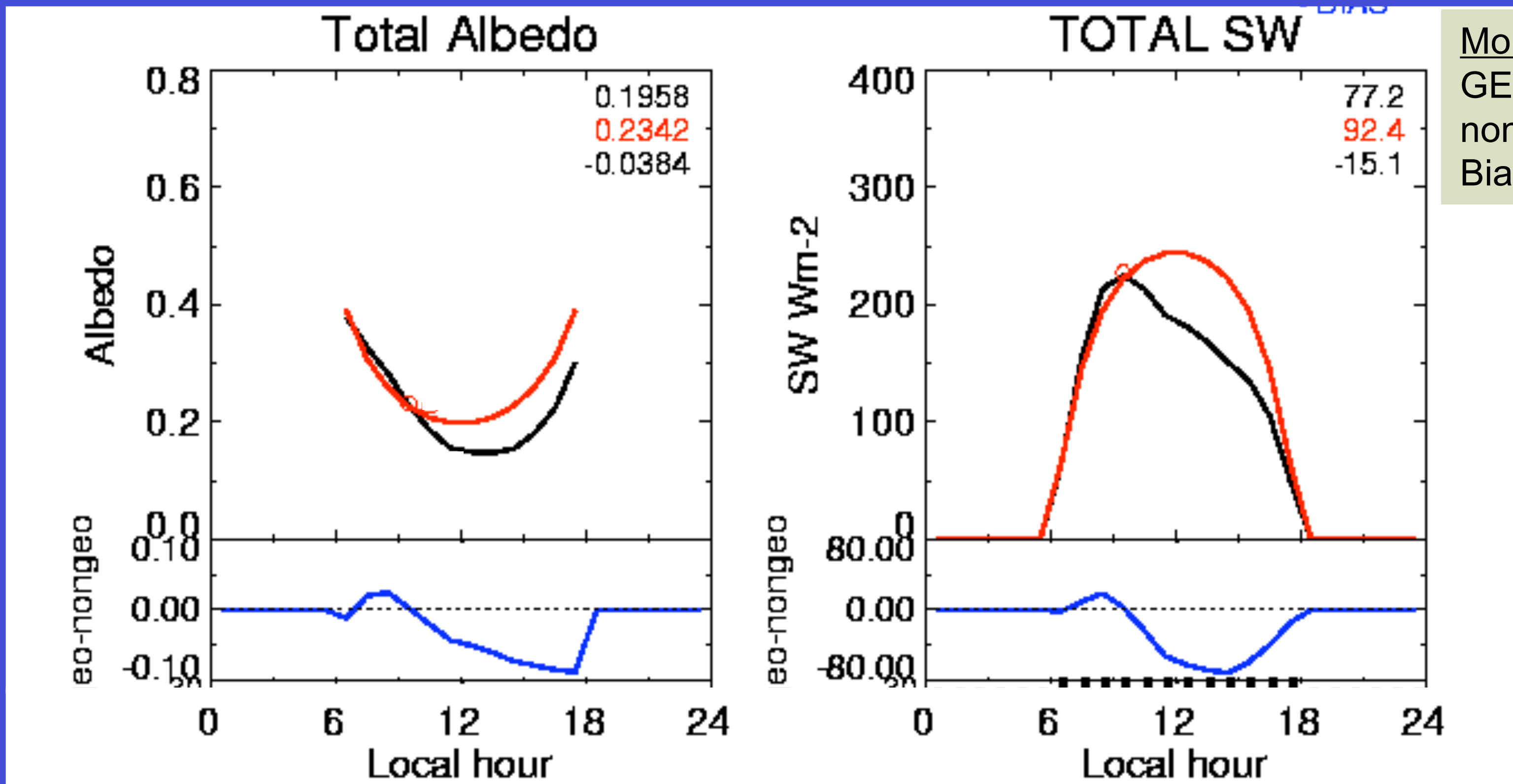
Why Include GEO Fluxes?



- Most regions sampled twice a day with either Terra or Aqua
- Terra & Aqua sample the poles up to 14 times/day
- Even after combining Terra and Aqua 8 hour gaps exist

- 3-hourly GEO fluxes adequately samples the diurnal cycle between ±60° latitude

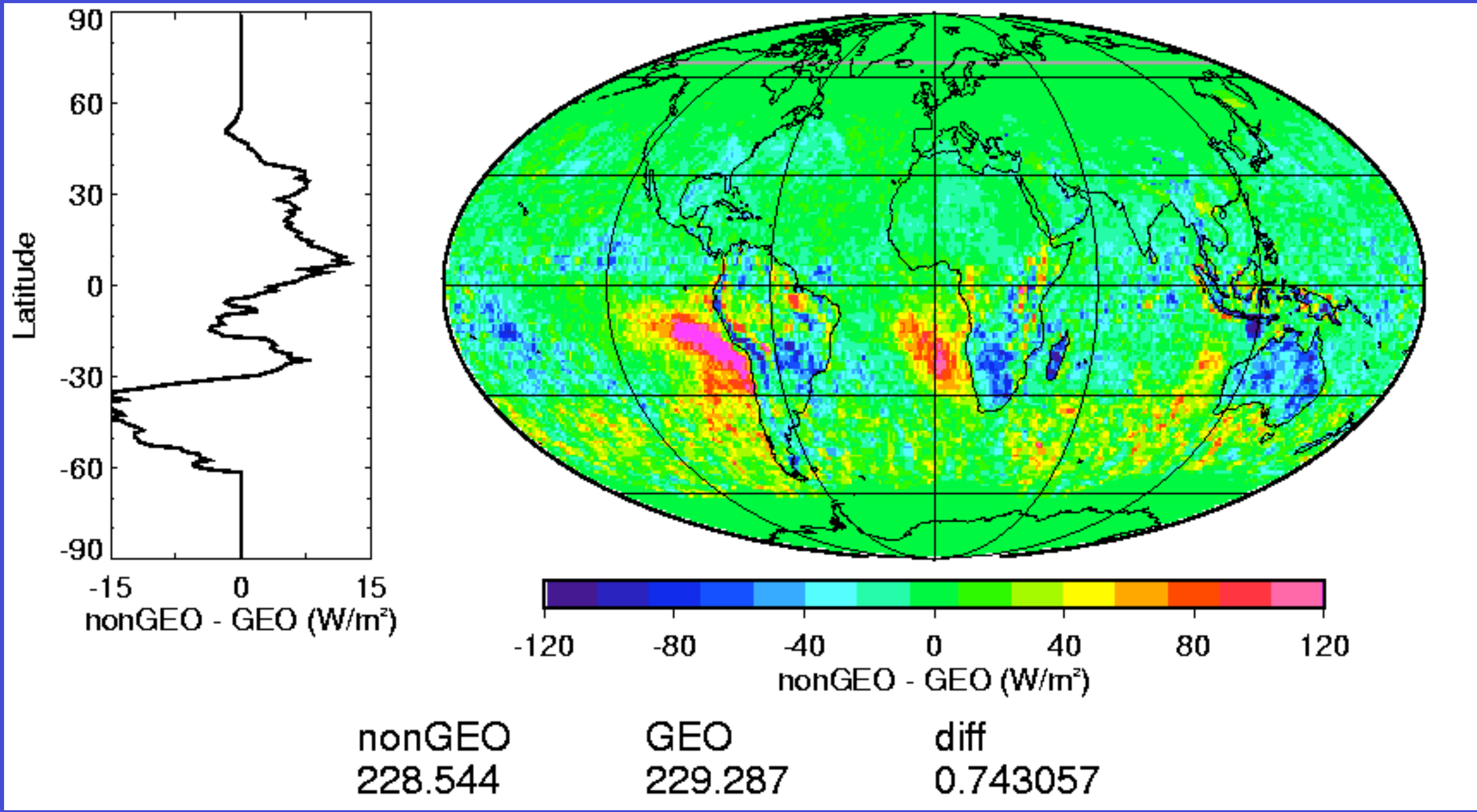
Monthly Hourly Albedo and SW Flux over Ecuadorian Stratus for Terra, July 2001



Monthly Means
GEO
nonGEO
Bias

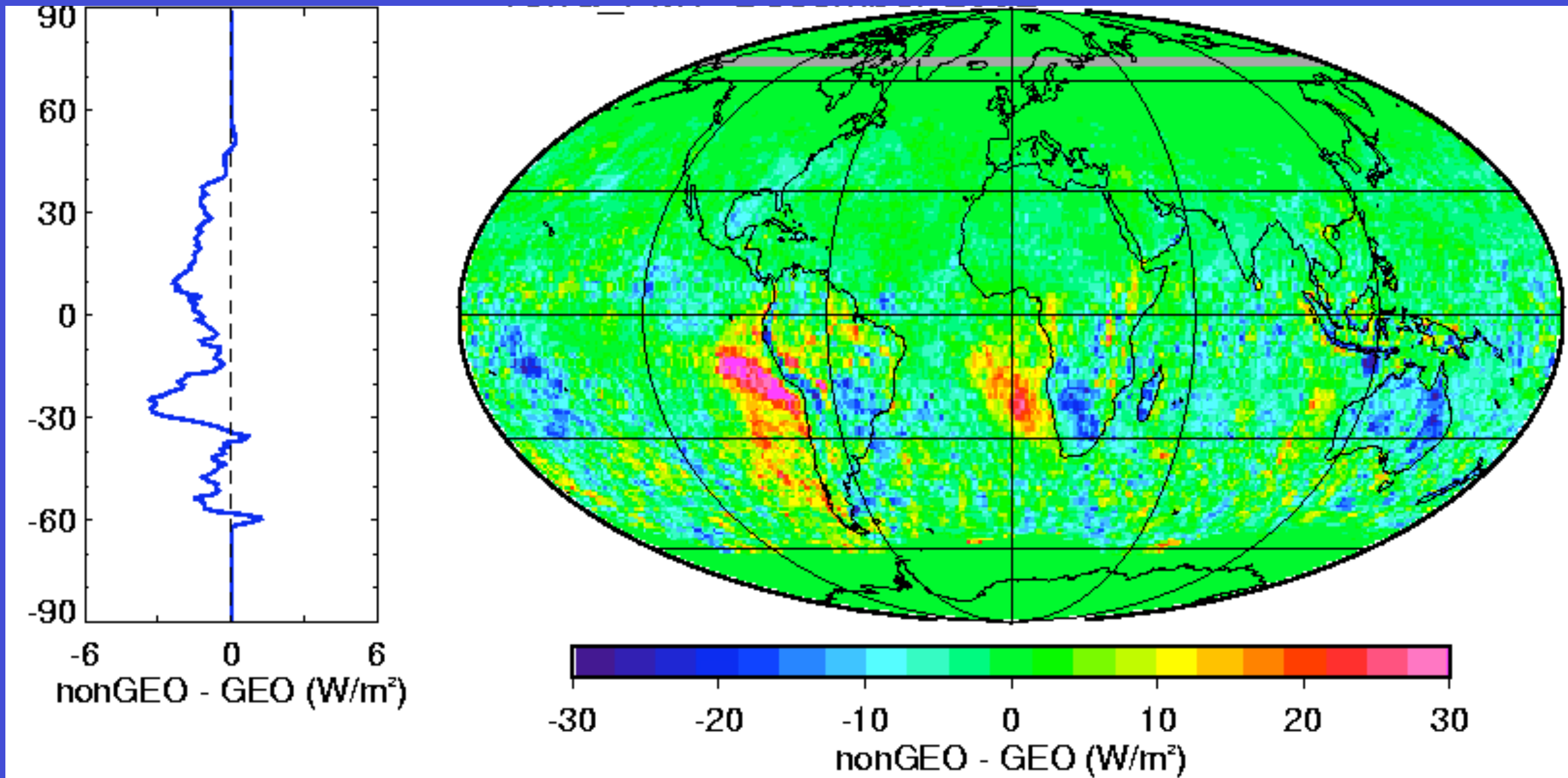
- ERBE temporal interpolation assumes constant meteorology (cloud properties) through out the day

nonGEO - GEO SW 14:30 monthly hourly mean Dec 2002



- Blue afternoon convection, Red afternoon cloud clearing
- Regional instantaneous differences can be ~ 100 Wm^{-2}

nonGEO - GEO SW monthly mean Dec 2002

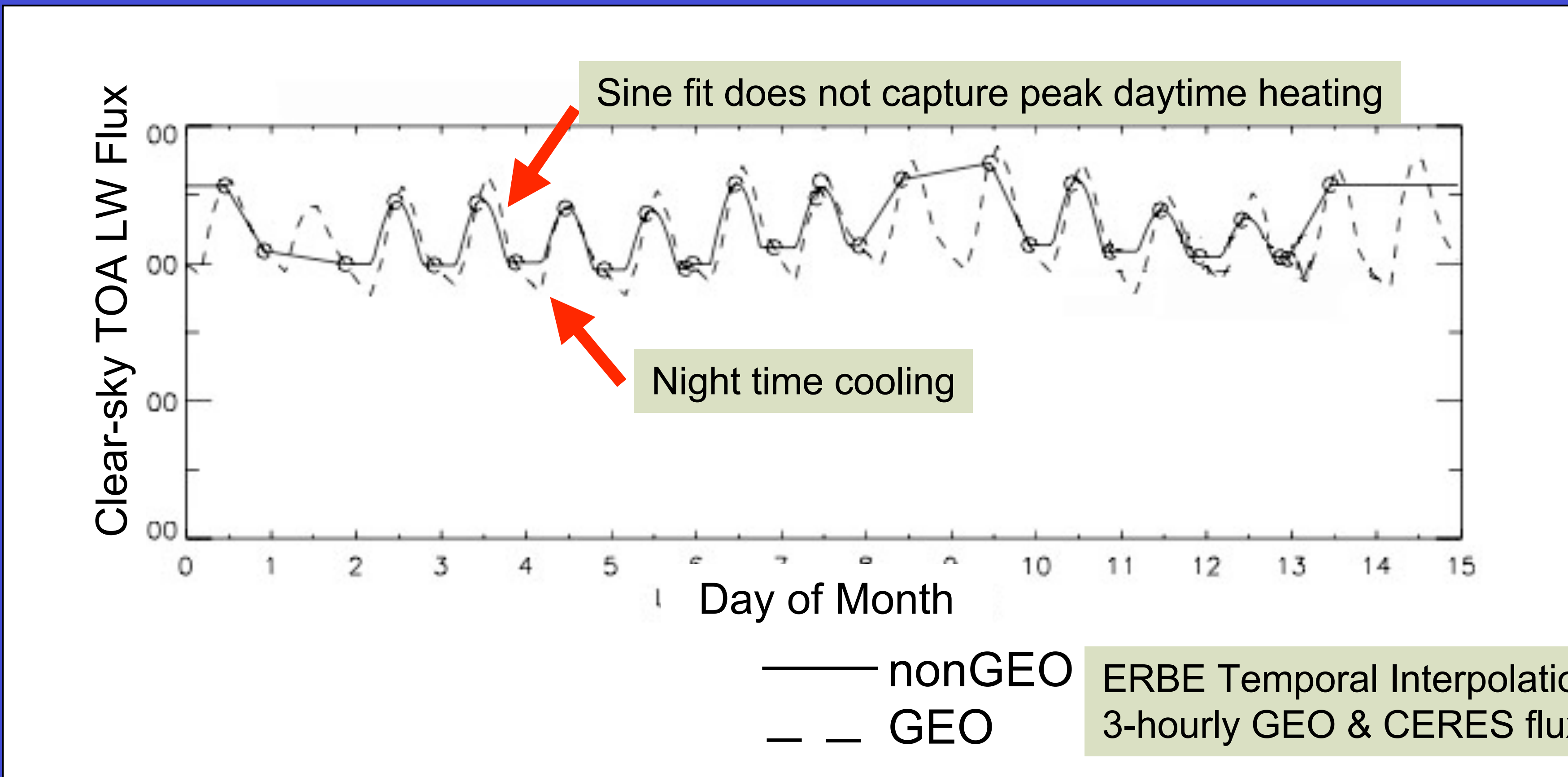


	nonGEO	GEO	Bias
Global	105.5	106.4	-1.0

- Blue afternoon convection, Red afternoon cloud clearing
- Regional monthly differences can be ~ 20 Wm^{-2}

Clear-sky TOA LW Flux

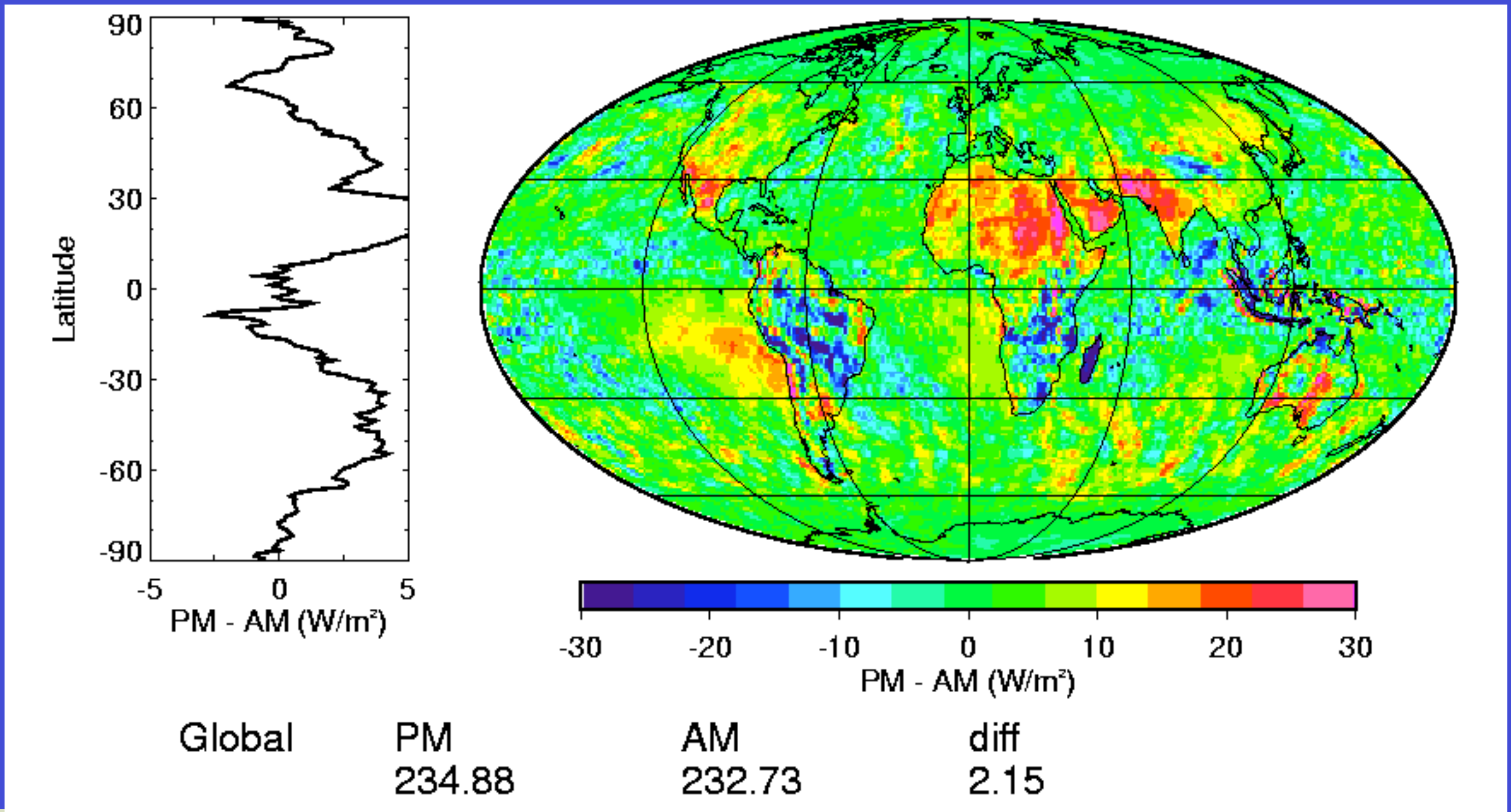
June 2001, Terra FM-1, Arizona Desert



ERBE Temporal Interpolation
3-hourly GEO & CERES fluxes

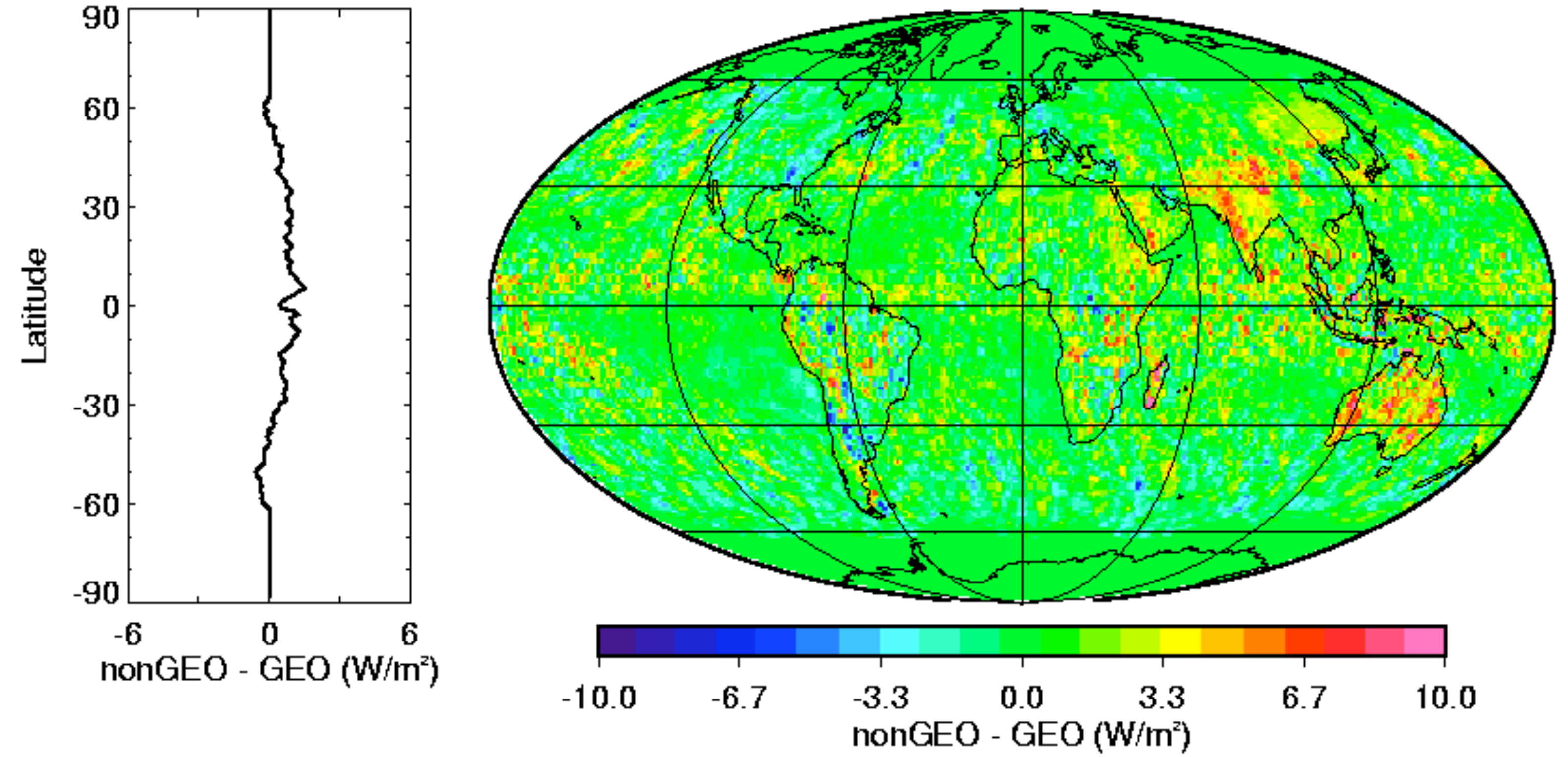
- ERBE temporal interpolation linearly interpolates between measurements over oceans
- Over land a half-sine fit is used to model diurnal heating if night time observations exist

GEO LW 16:30 (PM) - 7:30 (AM) monthly hourly mean Dec 2002



- For land: blue afternoon convection, red thermal lag
- PM-AM differences can be ~ 30 Wm^{-2}

nonGEO - GEO LW monthly mean
Dec 2002



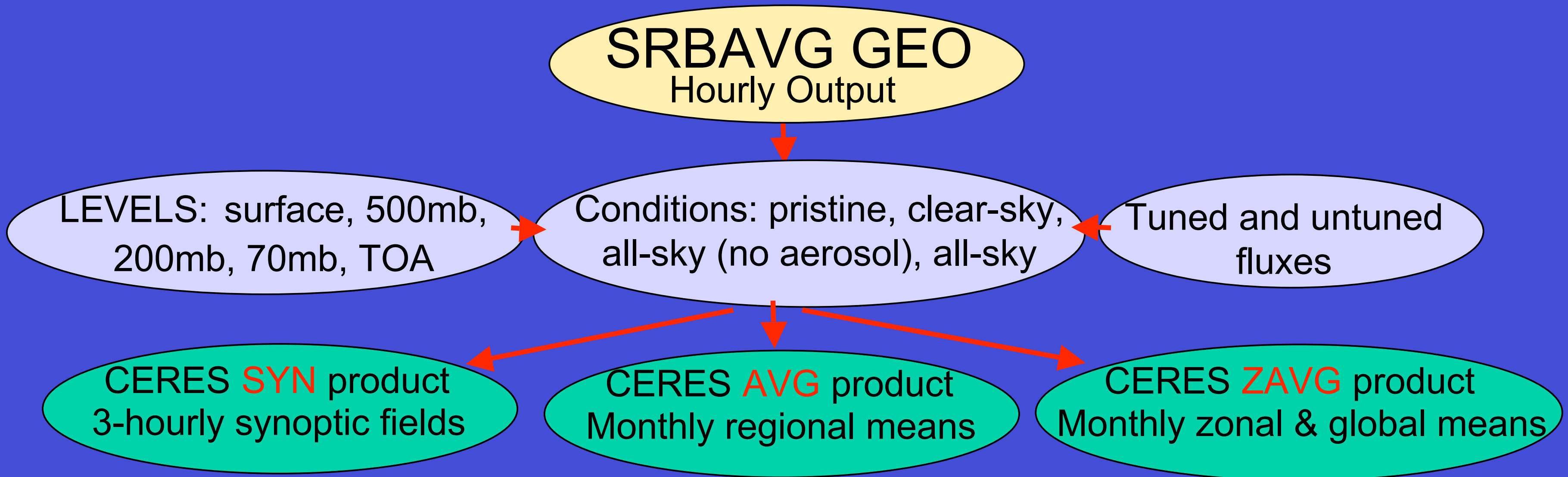
	nonGEO	GEO	nonGEO-GEO	reg RMS
Global	234.26	233.78	0.49	1.97

- On a global basis the diurnal signal is small

SYN/AVG/ZAVG Product

• Product Features:

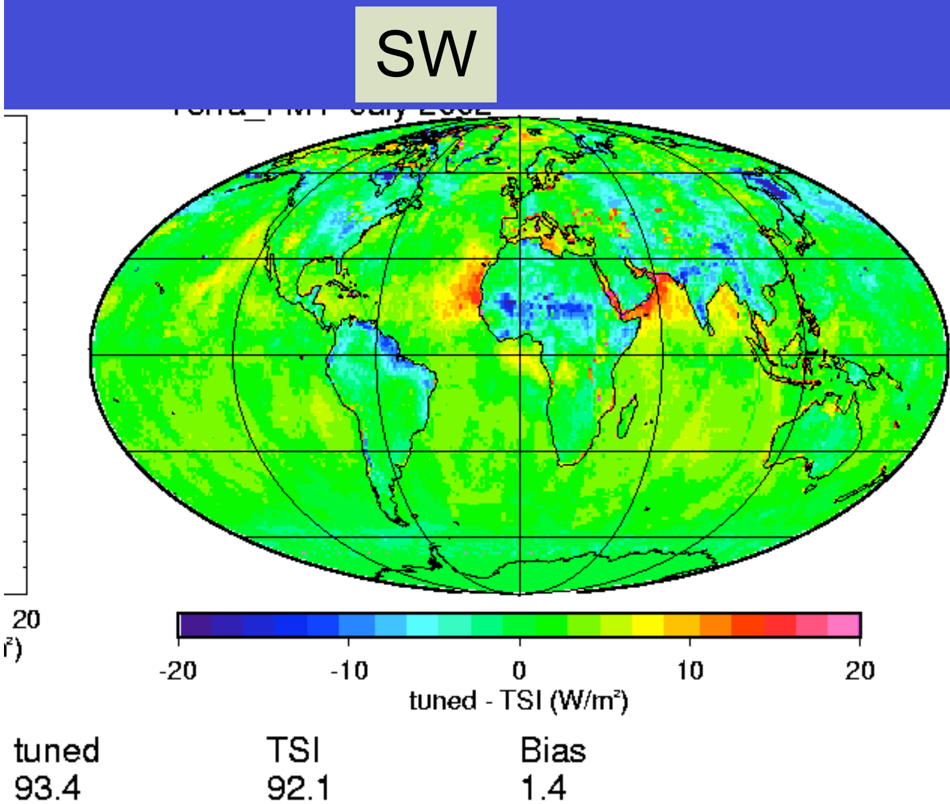
–Surface and atmosphere Fu-Liou radiative transfer modeled fluxes consistent with CERES observed TOA fluxes

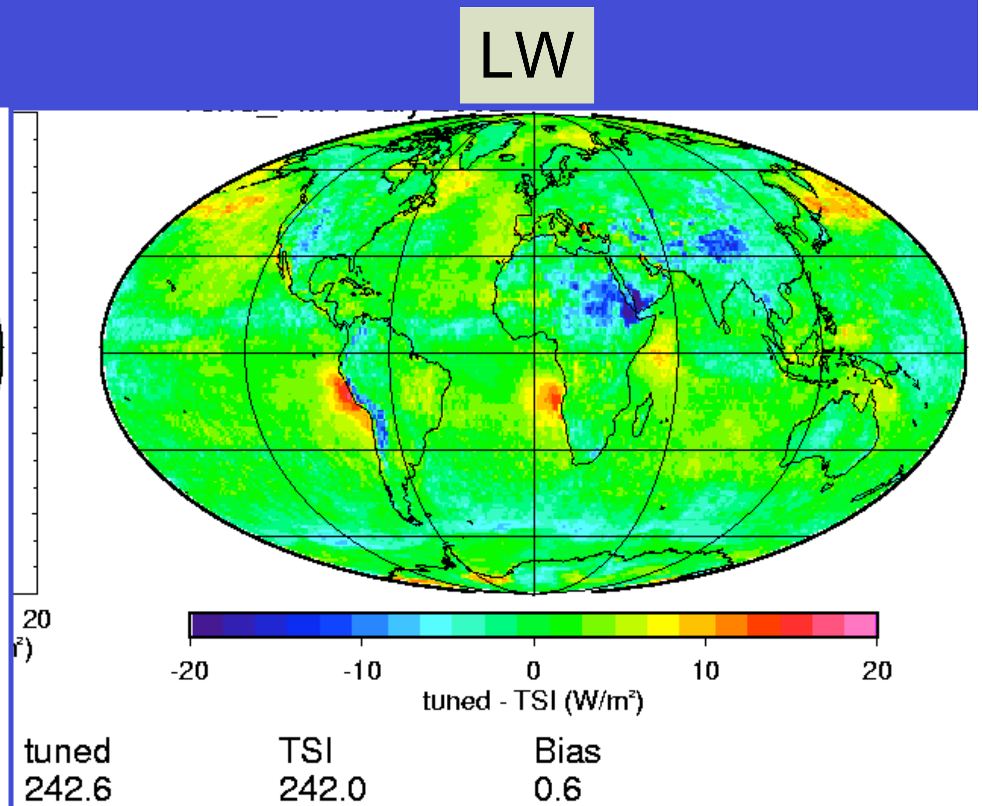


•Appropriate Usage:

–SYN fluxes and cloud properties can be compared directly with climate model results at the 3-hourly or monthly level

Tuned (SARB) - Observed (GEO)
July 2002





- Differences to be discussed by Fred Rose

CERES Instaneous Gridded Data Products

CERES PRODUCT	TRMM	Terra	Aqua
ERBE-like ES-9 ERBE gridded ES-8 fluxes	**Ed2** **Jan98-Aug98 & Mar00**	**Ed1CV (Mar00-present-2months)** **Ed2 (Mar00-Dec05)**	**Ed1CV (Jul02-present-2months)** **Ed2 (Jul02-Dec05)**
SFC CERES local time gridded fluxes and cloud products from SSF	**Ed2B** **Jan98-Aug98 & Mar00**	**Ed2C** **(Mar00-Dec05)**	**Ed2A** **(Jul02-Dec05)**
FSW CERES GMT synoptic gridded fluxes from SSF and CRS	**Ed2C** **Jan98-Aug98 & Mar00**	**ED2B** **(Mar00-Dec05)**	**Ed2A** **(Jul02-Dec05)** **Jan_2007**
SYN SARB 3-hourly syntopic gridded parameters		**Beta3 (Jan02-Dec02)** **Jan_2007** **Beta4 (Mar00-Feb03)** **Oct_2007**	**Beta4** **(Jul00-Jun03)** **Oct_2007**

- **Completed, Projected**

– First look at SSF and daily gridded CERES fluxes are available at FLASHFLUX within 6 days of real-time, (currently using Beta versions soon to be an Edition)

  - FLASHFLUX SSF use the same CERES ED2 routines and calibrated with the last update(~6 month delay), a separate product for Terra and Aqua
  - Daily gridded product uses the nonGEO ED2 algorithm but combines Terra and Aqua
  - http://eosweb.larc.nasa.gov/PRODOCS/flashflux/table_flashflux.html

CERES Monthly Gridded Average Data Products

CERES PRODUCT	TRMM	Terra	Aqua
ERBE-like Monthly mean ERBE-like product ES-4, ES-9	**Ed2** **Jan98-Aug98**	**Ed1CV (Mar00-present-2months)** **Ed2 (Mar00-Dec05)**	**Ed1CV (Jul02-present-2months)** **Ed2 (Jul02-Dec05)**
SRBAVG Monthly mean nonGEO and GEO products	**Ed2B** **Jan98-Aug98**	**Ed2D (Mar00-May04)** **Ed2D (Jun04-Dec05)** **Mar_2007** *	**Ed2A** **(Jul02-May04)** **May_2007**
AVG/ZAVG Monthly mean synoptic SARB product		**Beta3 (Jan02-Dec02)** **Jan-2007** **Beta4 (Mar00-Feb03)** **Oct_2007**	**Beta4** **(Jul02-Jun03)** **Oct_2007**

- **Completed, Projected**
- SYN 3-hourly TOA/Surface/Profile Flux and Cloud Averages, same schedule as AVG/ZAVG
- SRBAVG-Daily and ISCCP-like cloud pressure/optical depth datasets due Jan 2007
- Users must apply REV1 to all Ed2 SW fluxes, proceedure in DQS

SRBAVG-Daily

- Separate the GEO and nonGEO flux and cloud parameters
  - SRBAVG-daily**1** is the GEO (GEO & CERES) TOA, surface fluxes and clouds
  - SRBAVG-daily**2** is the nonGEO (CERES-only) TOA fluxes and MODIS clouds

- SRBAVG-daily2: also includes the MODIS product aerosols
  - daily 0.55µm Land aerosols (not in SRBAVG1)
  - daily 0.55µm, 0.87µm, 2.13µm Ocean aerosols
    - 0.65µm and 1.6µm (Ignatov aerosols) in SRBAVG1 product
  - Monthly zonal incoming solar flux
  - Daily Snow/Ice coverage maps (snow+ice+IGBP)

SRBAVG-ISCCPd2like

- GOAL: produce monthly mean cloud properties consistent with ISCCP D2 product format
  - Average cloud properties as a function of cloud height and optical depth

- User community already familiar with data format

SRBAVG-ISCCPd2like

- Separate GEO and MODIS daytime (<78° SZA) cloud properties
  - SRBAVG-ISCCPd2like<u>**1**</u> is GEO-only (60°N-60°S)
  - SRBAVG-ISCCPd2like<u>**2**</u> is MODIS-only

- Classify each of the regional 4 cloud layer observation according to ISCCP cloud types
- Place each observation into one of the eight 3-hourly GMT bins
  - GEO-only is 3-hourly data (60°N-60°S)
  - MODIS-only is usually observed once during daytime
    - GMT bin is based on longitude, due to Terra sun-synch orbit
  - The 9th GMT is the monthly mean
    - MODIS-only 9th GMT bins is essentially the 10:30 AM local bin
- SRBAVG-ISCCPd2like structure
  - (mean)x(360by180 regions)x(15 cloud types)x(9 GMT)

ISCCP 15 daytime cloud types

Cloud top (mb)			
High 50-440	Cirrus ice=13	Cirrus-stratus ice=14	Deep Convective ice=15
Mid 440-680	Alto-cumulus liq=7, ice=10	Alto-stratus liq=8, ice=11	Nimbo-stratus liq=9, ice=12
Low 1000-680	Cumulus liq=1, ice=4	Strato-cumulus liq=2, ice=5	Stratus liq=3, ice=6
Cloud optical depth	0.0-3.6	3.6-23	23-380
	Thin	Mid	Thick

SRBAVG-ISCCPd2like parameters

Cloud Parameter	MODIS-only	GEO-only
Cloud Fraction	X	X
Effective Pressure	X	X
Effective Temperature	X	X
Optical Depth	X	X
Liquid/Ice Water Path	X	X
Particle size (radius, diameter)	X	
Infrared Emissivity	X	
# of days/GMT box	X	X

Langley DAAC Ordering Web Page

ATMOSPHERIC SCIENCE DATA CENTER

CERES Level 3 Data Sets

Level 1B Data Sets | Level 2 Data Sets | CERES Data Sets

The CERES data products are written in HDF format. (Information on HDF)

Available Level 3 Data Sets
(Monthly Averages)

CERES Data Product	Frequency	Approximate File Size	Parameter List
ERBE-like Geographical Averages (ES-4)	1/Month	8.8 MB	ES-4
TOA/Surface Averages (SRBAVG)		963/1171 MB	SRBAVG
ERBE-like Regional Averages (ES-9)		72.4 MB	ES-9
Gridded Single Satellite Fluxes and Clouds (FSW)		644 MB	FSW
Gridded TOA/Surface Fluxes and Clouds (SFC)		325 MB	SFC

For convenience in ordering a specific CERES data product through the Langley Web Ordering Tool, select the Data Set Name in the tables below.

ES-4 | SRBAVG | SRBAVG Daily | SRBAVG ISCCP | ES-9 | FSW | SFC

Daily TOA/Surface Averages (SRBAVG-Daily):
Daily regional, zonal, and global averages of the TOA and surface LW and SW fluxes and cloud parameters for each 1-degree equal-angle region.
(SRBAVG-Daily1 files contain GEO flux and cloud parameters, SRBAVG-Daily2 files contain non-GEO flux and cloud parameters)

Select Parameters: Clear-sky and All-sky TOA Fluxes, Surface (Radiative) Fluxes, OLR, Clear-sky and All-sky Albedo, Cloud Properties, Surface Types
Complete Parameter List

Documents: Description/Abstract.

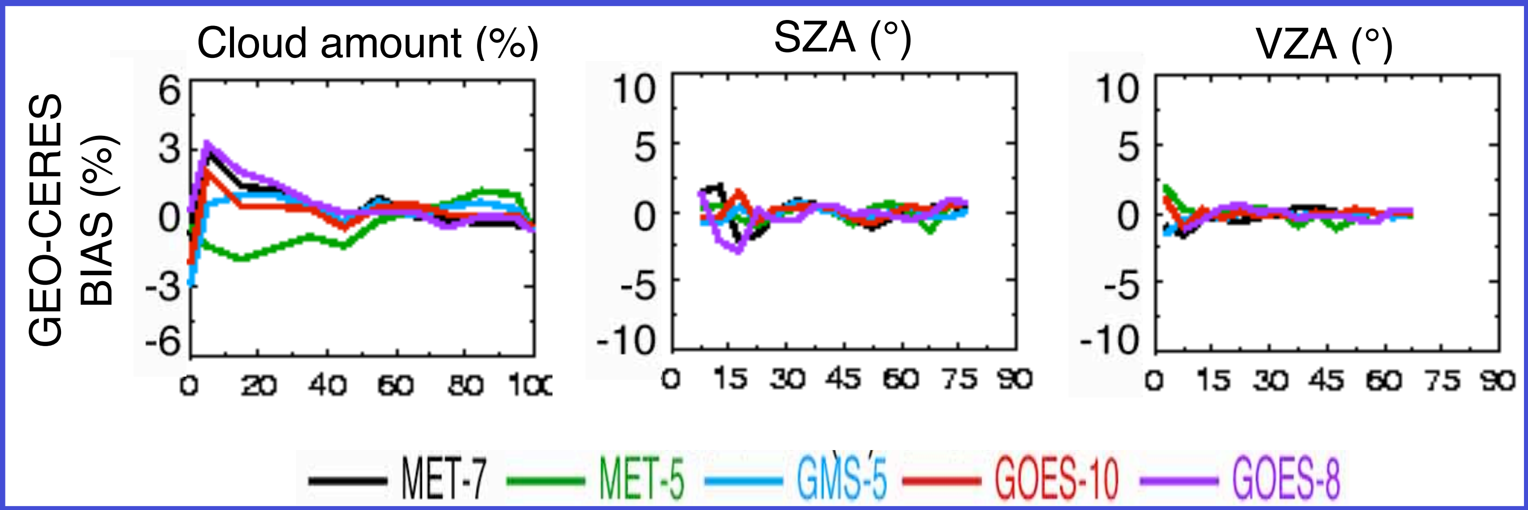
Spacecraft	Data Set Name (Select name to order)	Data Products Catalog	Sample Software	Temporal Coverage (Monthly)
Terra (covers opened 02/25/2000)	Daily SRBAVG files: CER_SRBAVG-Daily_Terra-FM1-MODIS_Edition2D, CER_SRBAVG-Daily_Terra-FM2-MODIS_Edition2D, Quality Summary.	DPC_SRBAVG_R3V4	Readme | Read Package (C)	03/2000 - 02/2003

http://eosweb.larc.nasa.gov/ under CERES and Level 3

GEO Narrowband to Broadband

- GEO visible and IR radiances are calibrated against MODIS
- GEO Cloud properties
  - Uses subset of CERES MODIS cloud algorithm based on VIS and IR radiances, need to convert radiances into fluxes
- GEO Narrowband to Broadband radiance conversion
  - First adjust GEO radiance to MODIS using models
  - MODIS equivalent to broadband radiance using model based on coincident MODIS and CERES measurements
- CERES ADMs are used to convert GEO broadband radiances into fluxes
- GEO derived LW hourly flux data stream is normalized with CERES measurements at observed CERES times
  - Normalization of GEO SW flux data stream with CERES caused significant regional biases and functionality with SZA, VZA and cloud amount
- GEO derived instantaneous SW fluxes are regressed monthly against coincident CERES observed fluxes over a 5°x5° domain

SW GEO-CERES Ocean Biases for Jan 2001



• GEO Biases <3% as a function of cloud amount, SZA and VZA

GEO Derived Flux Validation

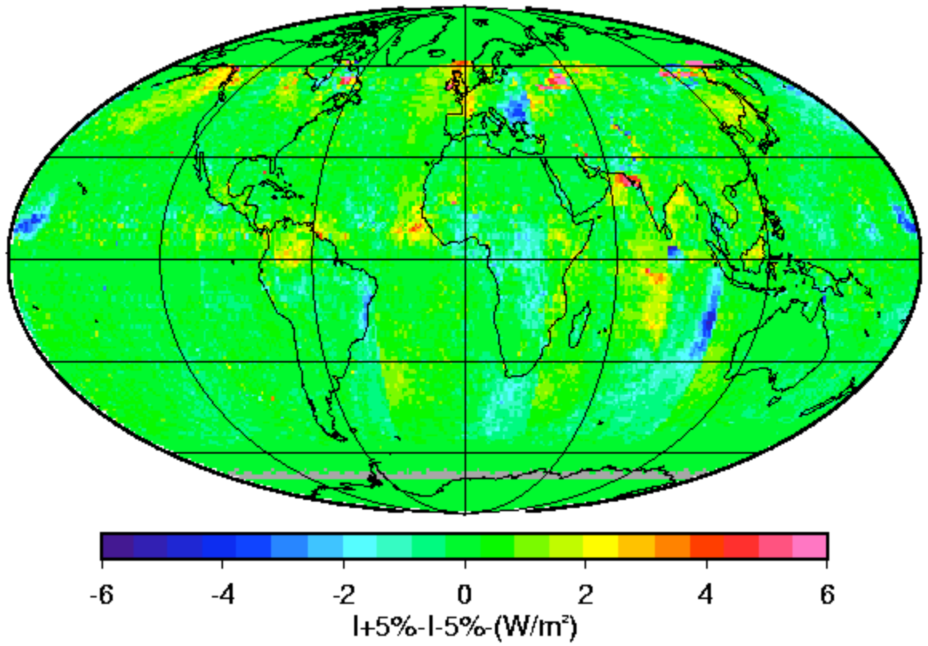
- Aqua Terra Comparisons
  - Tests the instantaneous interpolation accuracy
- GEO calibration sensitivity study (VIS ±5%, IR ±5%)
  - Test effectiveness of GEO-CERES normalization
- 1 vs 3 hourly GEO derived fluxes
  - Tests for temporal sampling sensitivity
- Comparison of GEO surface fluxes with Surface flux measurements
  - Surface network provides an independent high temporal resolution data set
- Comparison of GEO BB fluxes with SARB fluxes
  - Consistency between cloud properties and fluxes
- Principal component (EOF) analysis of flux fields
  - Test for potential GEO viewing artifacts
- GEO derived directional models
  - Tests the NB-BB consistency with SZA
- GERB will ultimately provide the best independent high-resolution data set for testing the interpolation of GEO data

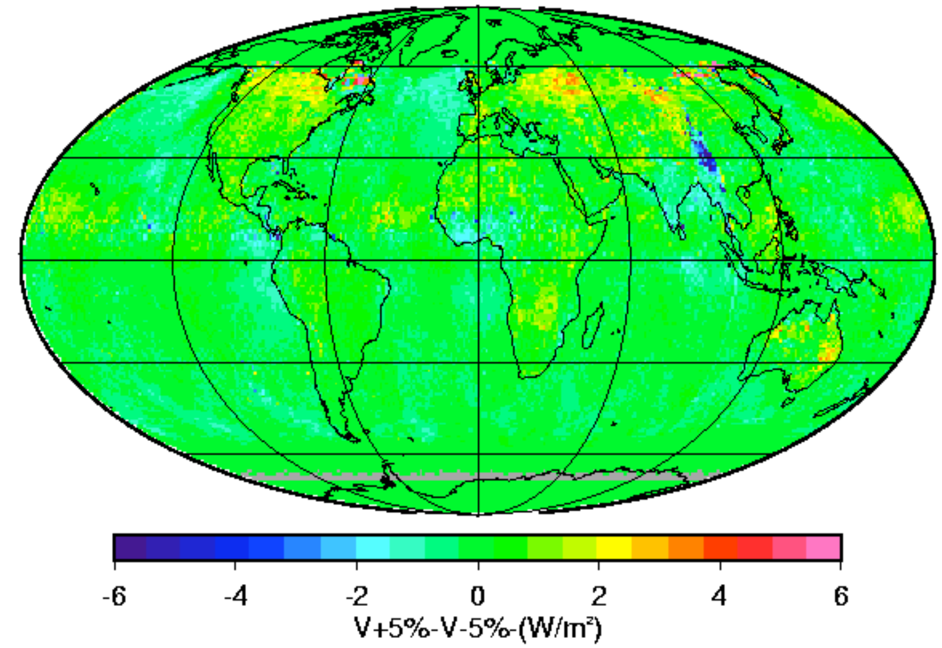
GEO Calibration Sensitivity

- GEO calibration sensitivity study
  - Test the effectiveness of the GEO-CERES normalization
- GEO imager data
  - Poorly calibrated
  - GEO radiances are calibrated against MODIS
  - Calibration accuracy VIS 3-5% and ~1% IR
- Method
  - Modify the GEO radiances by ±5%
  - Reprocess GEO cloud analysis and rederive GEO fluxes
  - Compare monthly mean fluxes to assess impact

Change in Total-Sky TOA SW Flux, July 2002

(IR+5%) - (IR-5%) **(VIS+5%) - (VIS-5%)**





BIAS: 0.10 Wm^{-2} (0.11%)
Regional RMS: 0.81 Wm^{-2} (0.89%)

BIAS: 0.01 Wm^{-2} (0.01%)
Regional RMS: 0.70 Wm^{-2} (0.76%)

- Plotted differences are for 10% change in calibration
  - 2x the expected uncertainty in SW, and 10x in LW

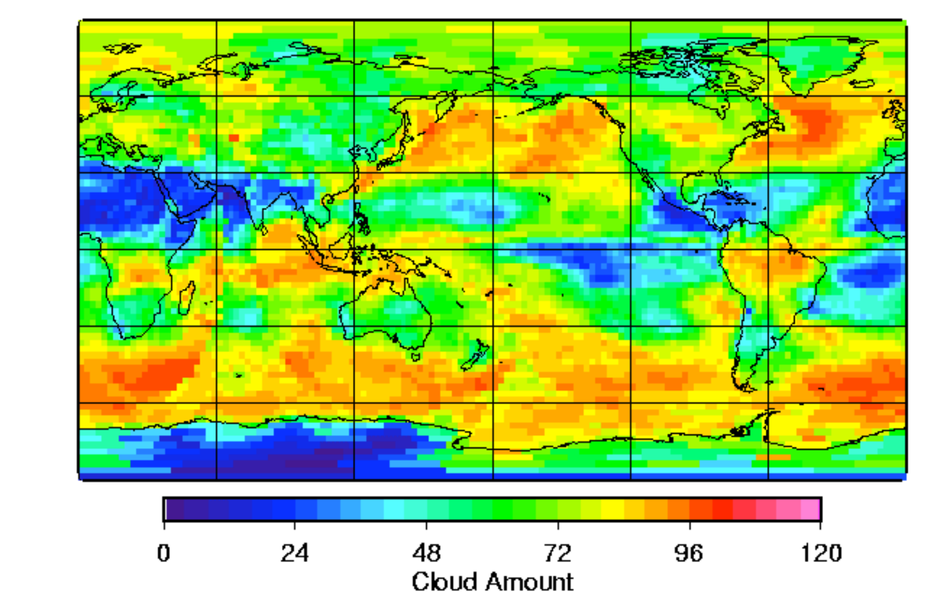
Principal Component Analysis

- Purpose
  - Test for potential GEO viewing geometry artifacts
  - Looking for GEO satellite patterns
- Method
  - Analyze TOA LW and SW Flux fields
    - (360 longitude)x(180 zones)x(36 months)
- Search for EOF GEO artifacts
  - Compare nonGEO- GEO fluxes de-seasonalized fluxes
  - Deseasonalized fluxes very sensitive to GEO calibration issues

EOF Analysis

Look for GEO viewing artifacts

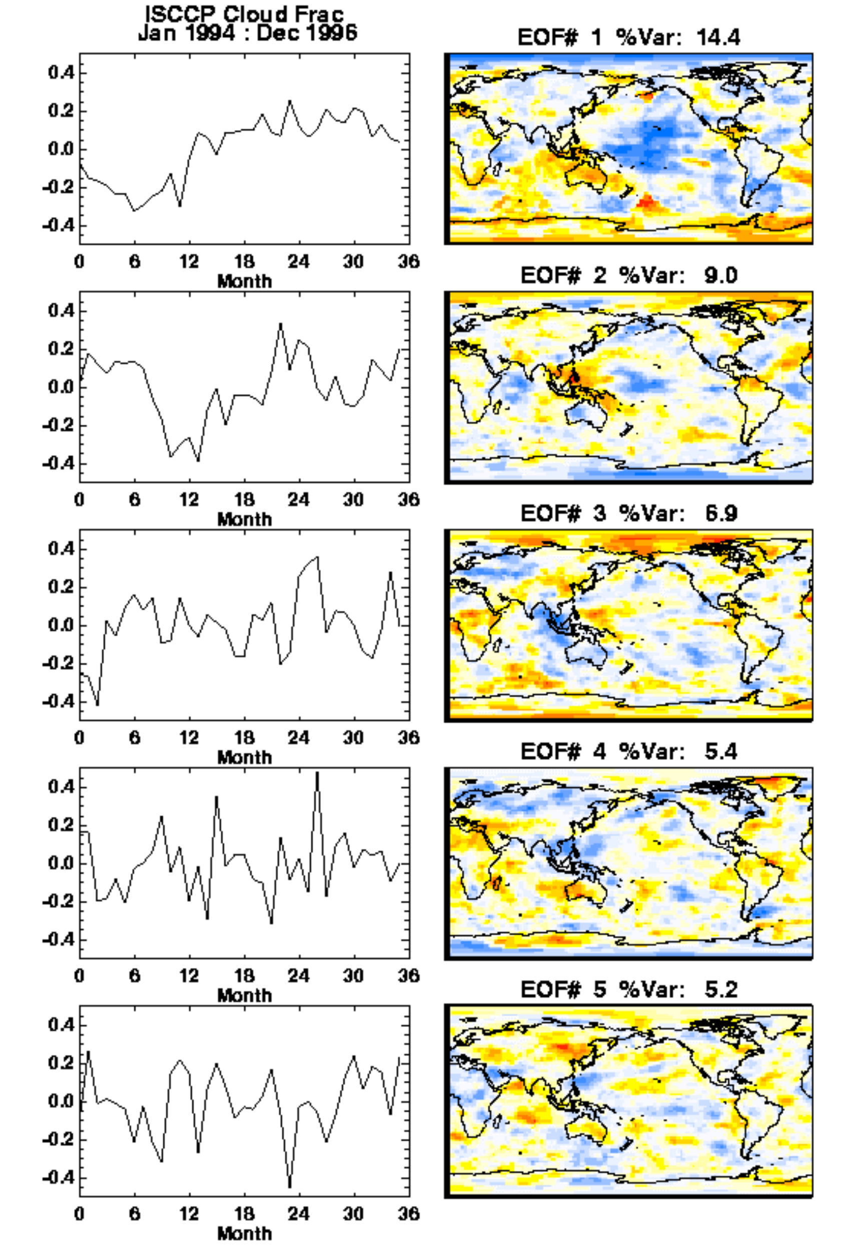
ISCCP cloud amount, Feb 1994



MET-7 GMS-5 GOES9 GOES8

ISCCP cloud amount,

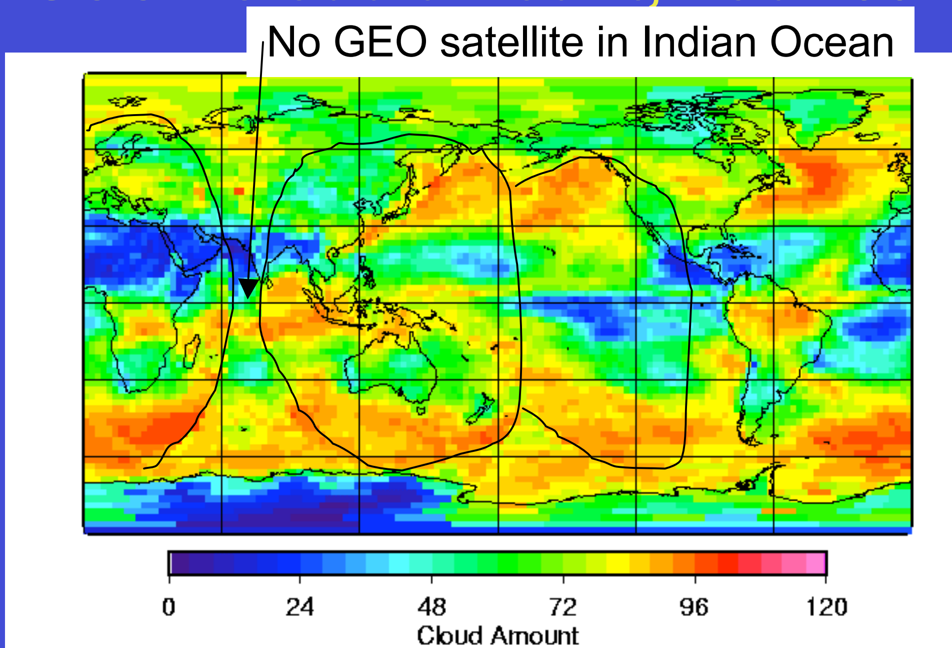
Jan 1994-Dec 1996, de-seasonalized



EOF Analysis

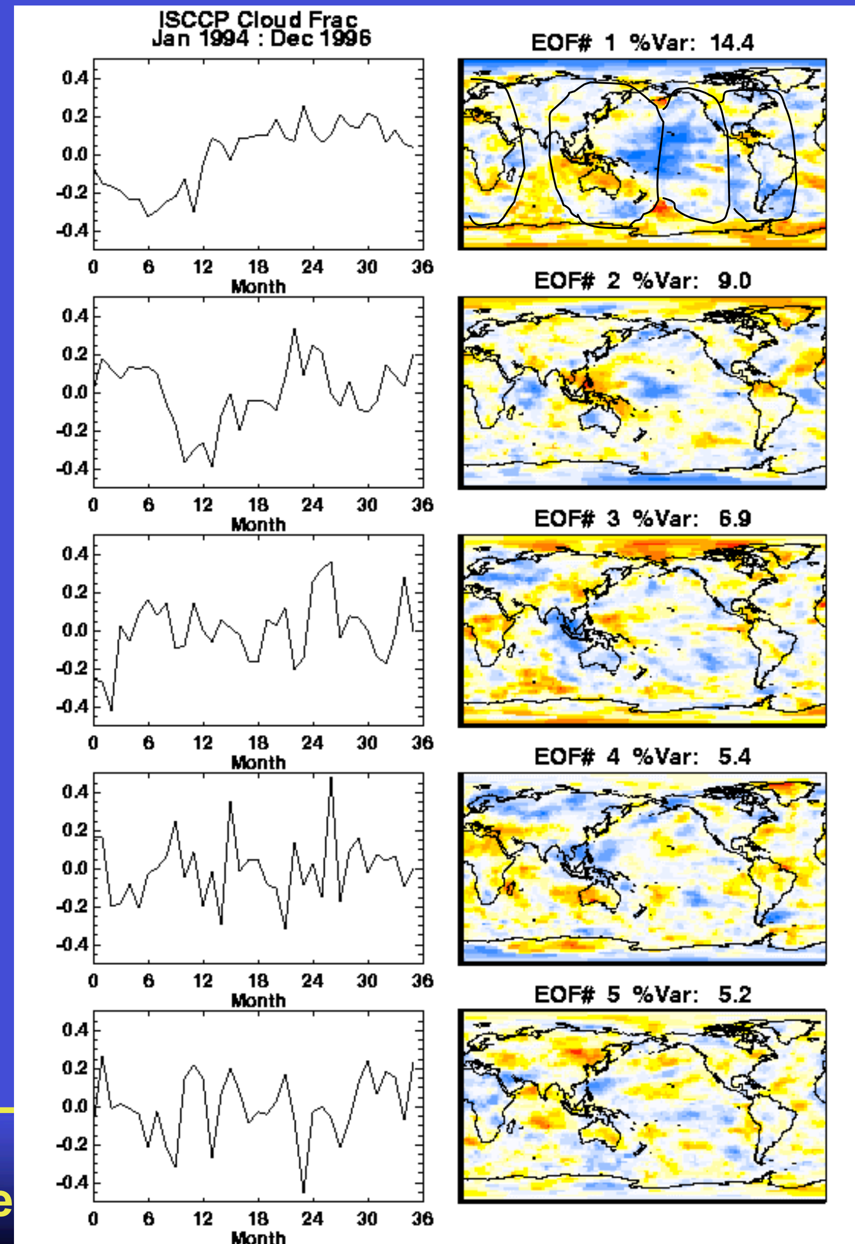
Look for GEO viewing artifacts

ISCCP cloud amount, Feb 1994



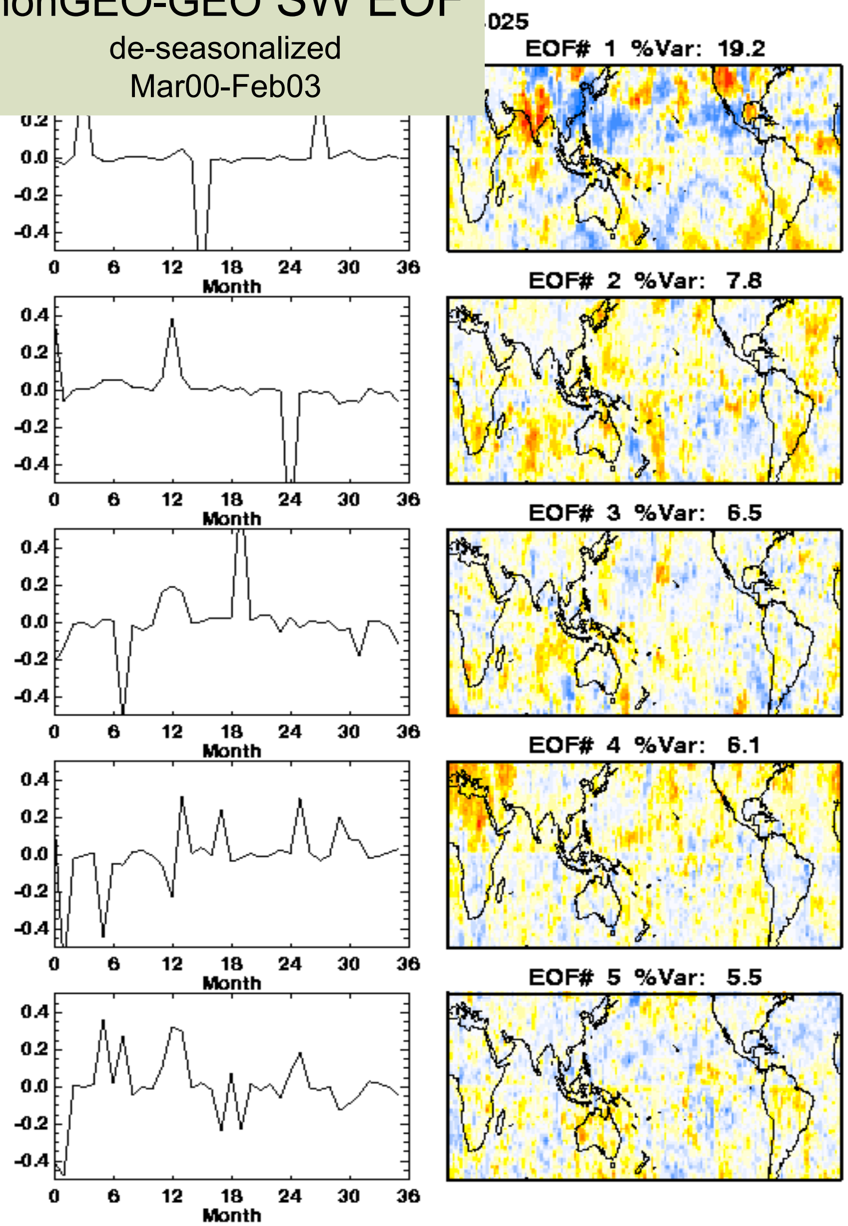
MET-7 GMS-5 GOES9 GOES8

ISCCP cloud amount, Jan 1994-Dec 1996, de-seasonalized



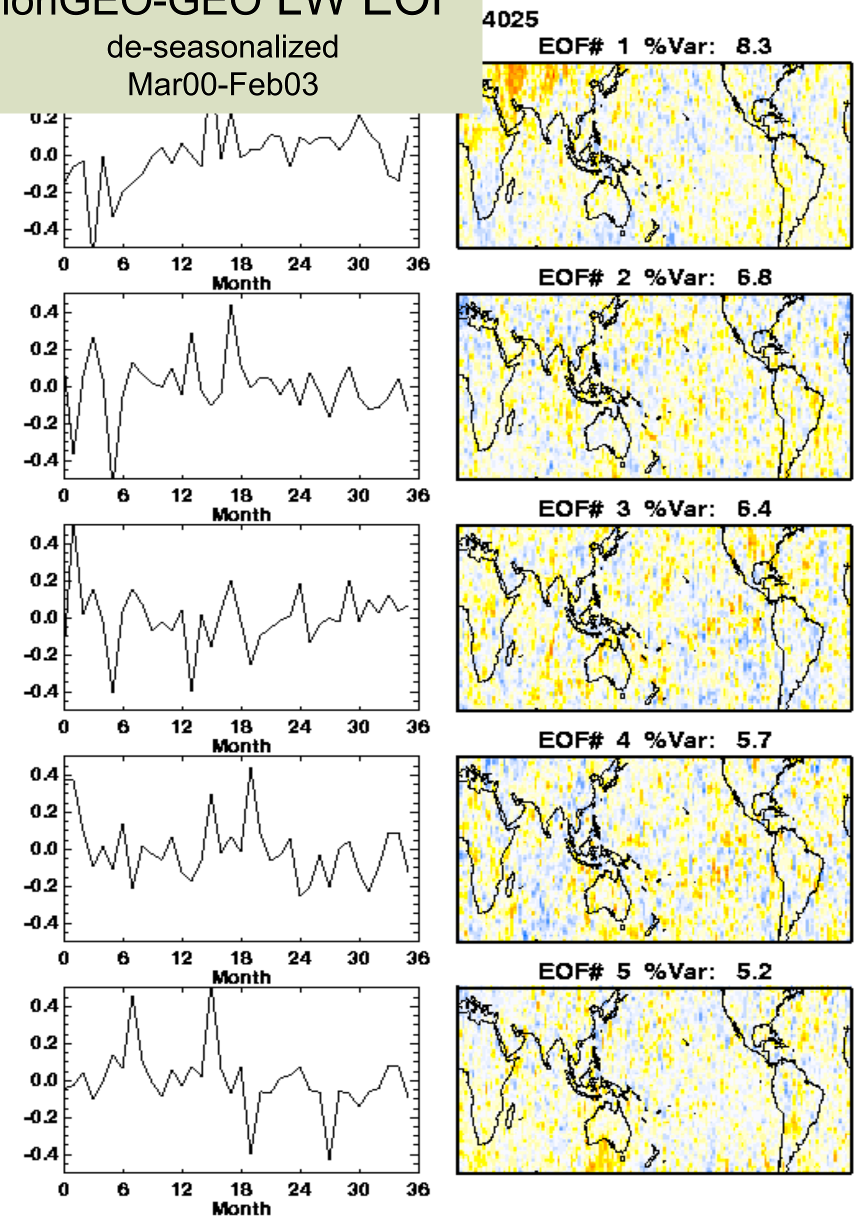
nonGEO-GEO SW EOF

de-seasonalized
Mar00-Feb03



nonGEO-GEO LW EOF

de-seasonalized
Mar00-Feb03



- No GEO artifacts observed in the SRBAVG-GEO fluxes
- De-seasonalized flux EOFs tend to bring out the GEO viewing artifacts

es

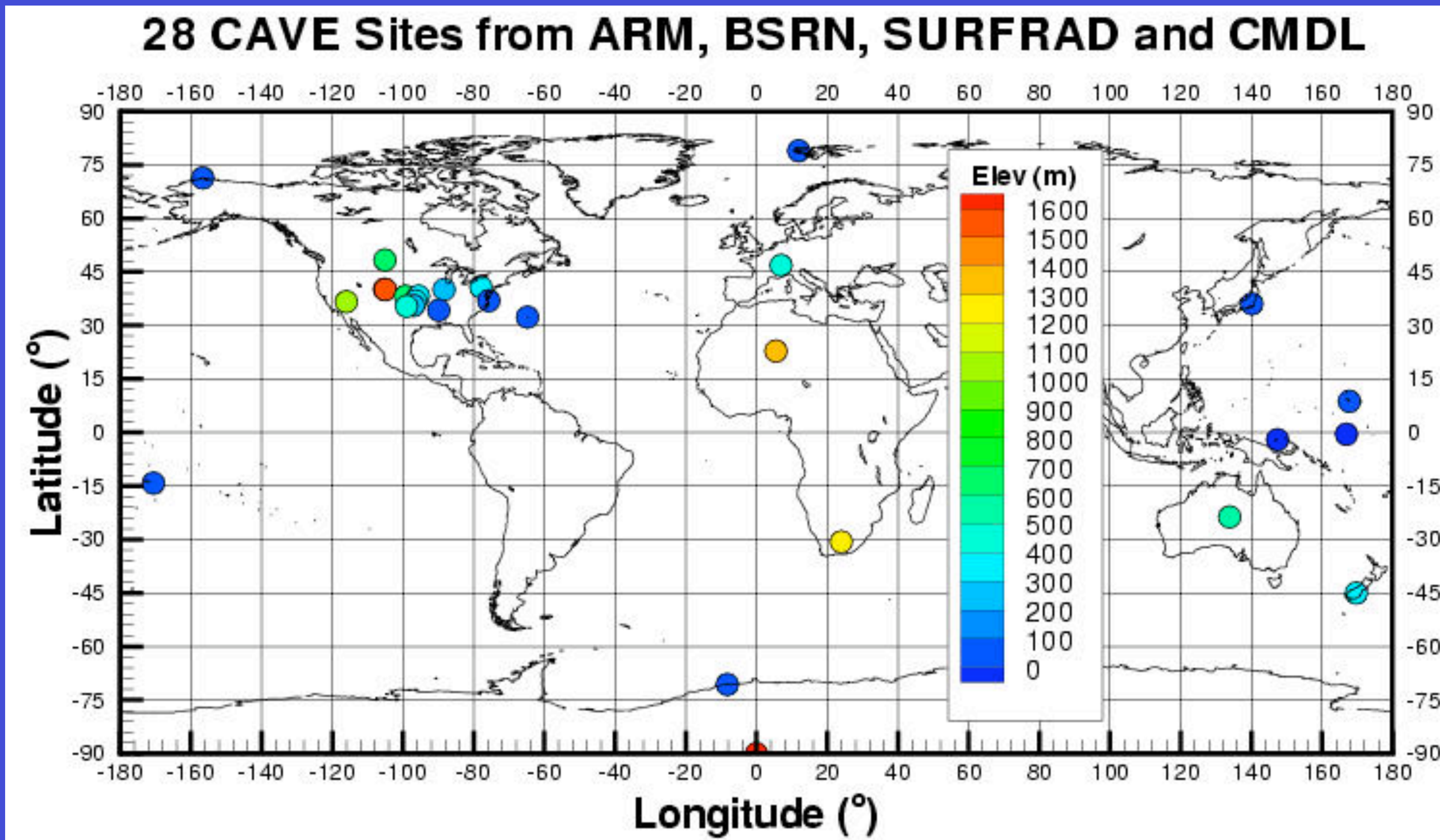
Surface Flux Comparison Purpose

- Test CERES-derived surface fluxes with the surface data network
- Surface flux data is one of the few independent high resolution datasets available

Surface Flux Comparisons

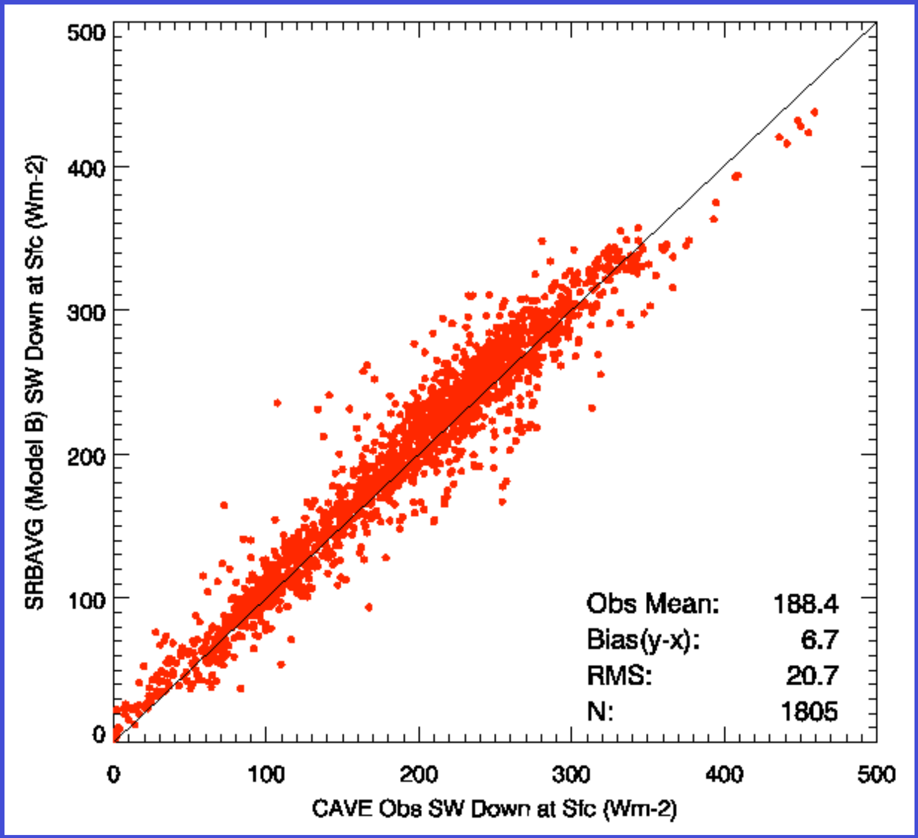
- LPLA Longwave fluxes (Model B, Gupta)
  - Surface longwave fluxes are independent from TOA
  - GEOS4 atmospheric state vertical profiles
  - GEO (low) cloud base heights
- LPSA shortwave fluxes (Model B, Gupta)
  - SW TOA major component
  - Cloud Amount
  - Cloud optical depth
- SRBAVG surface fluxes are from the GEO product
  - After temporal interpolation of TOA fluxes, compute Model B surface flux for every hourbox
- Monthly site surface fluxes from CAVE
  - ARM, SURFRAD, CMDL, and BSRN quality controlled surface radiometer networks
  - 6 years of monthly fluxes per station (Mar00 to Dec05)
  - 28 stations across the globe

Surface Sites Used In Comparison

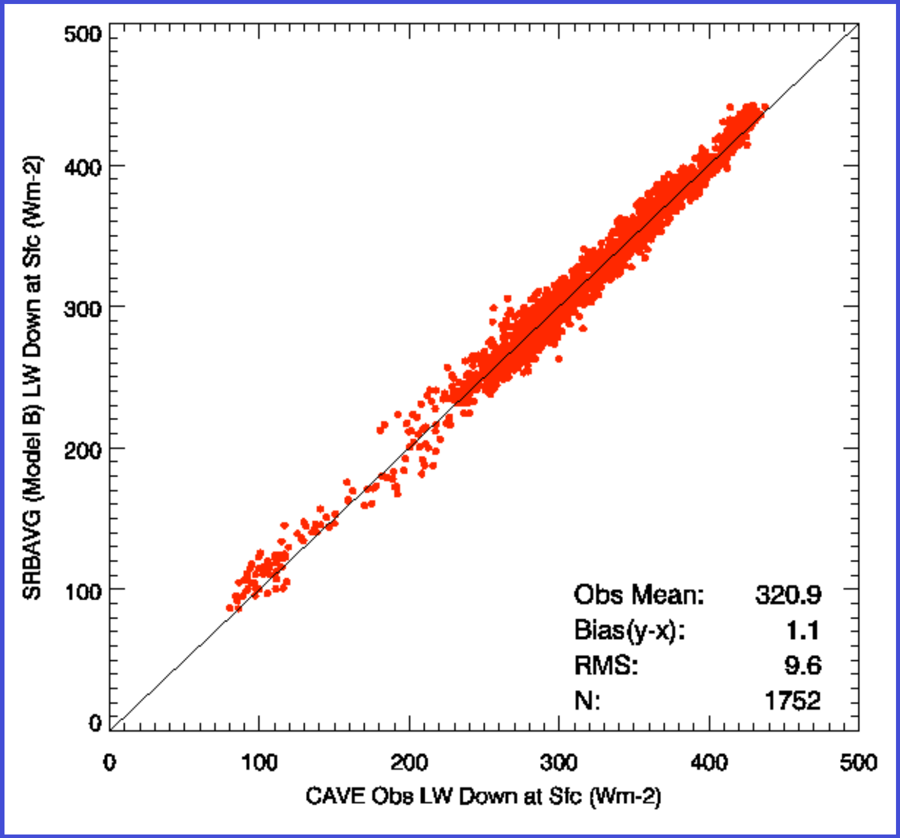


Comparison of ground site and SRBAVG monthly surface fluxes (Mar00-Dec05)

SW ↓



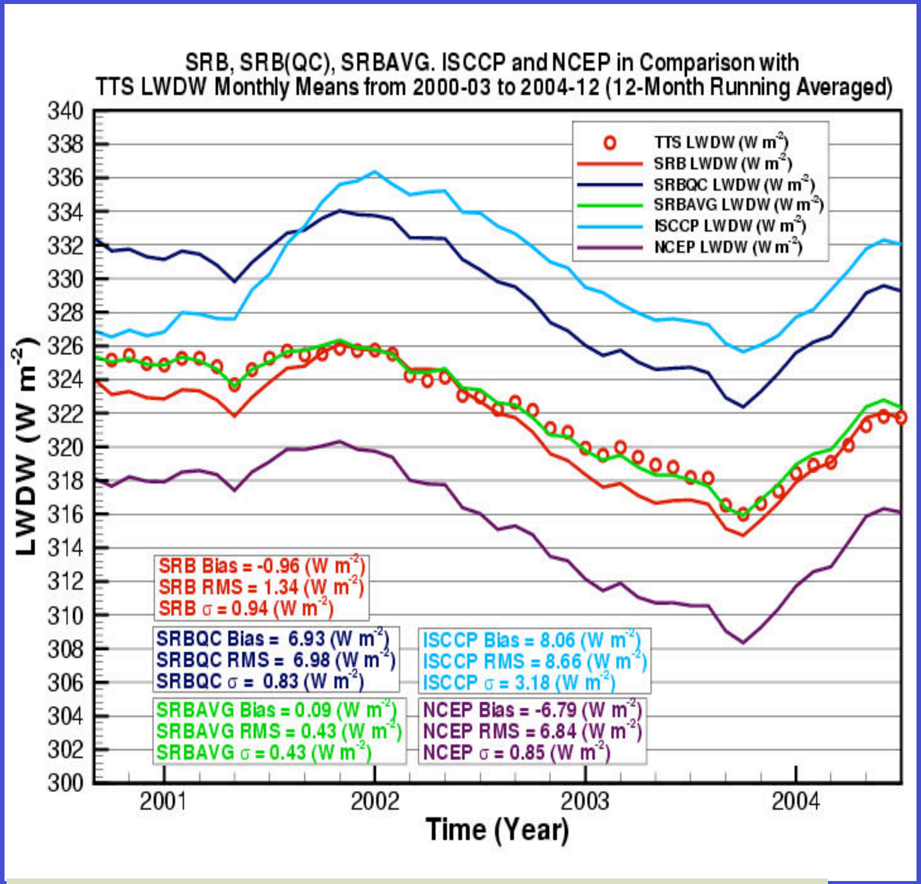
LW ↓



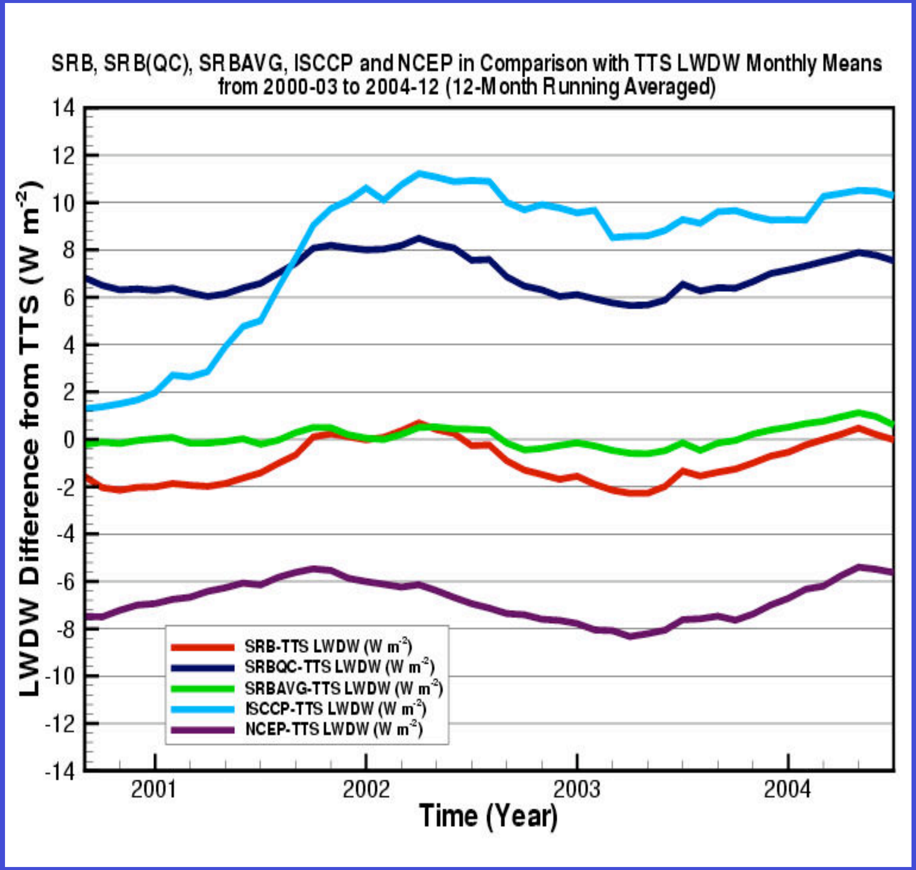
- Biases are consistent with SOFA on SSF

Comparison of Monthly Surface LW↓ fluxes 12 month running means, (Mar00-Dec04)

Product trendlines



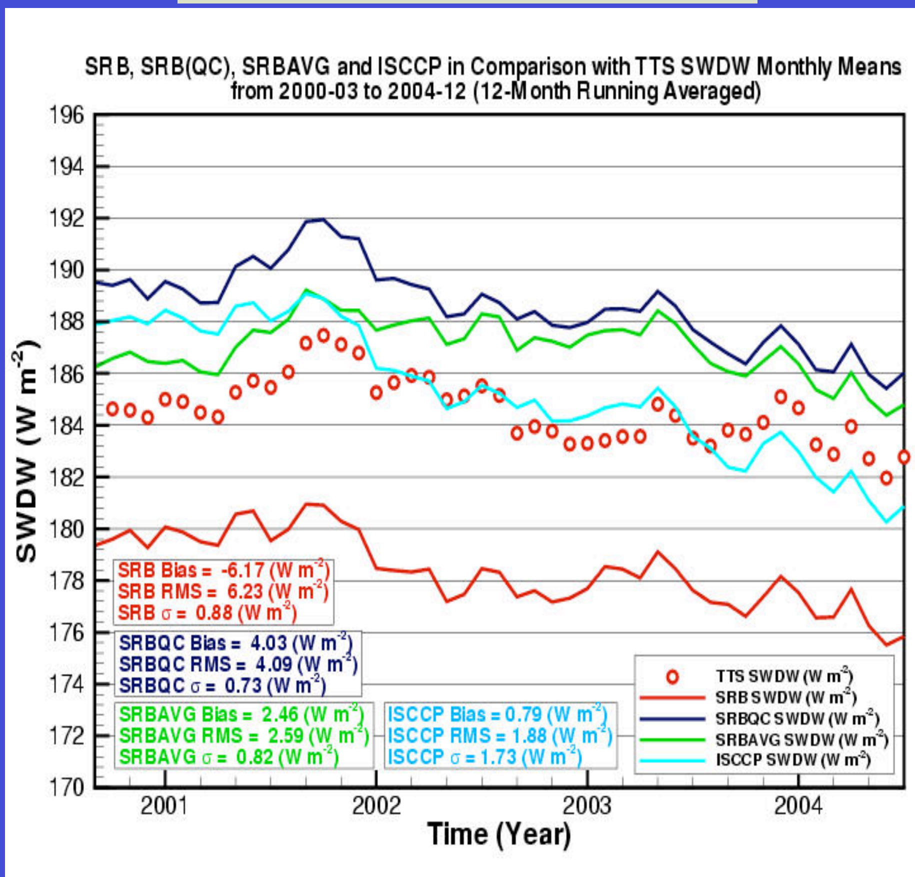
Product - ground site



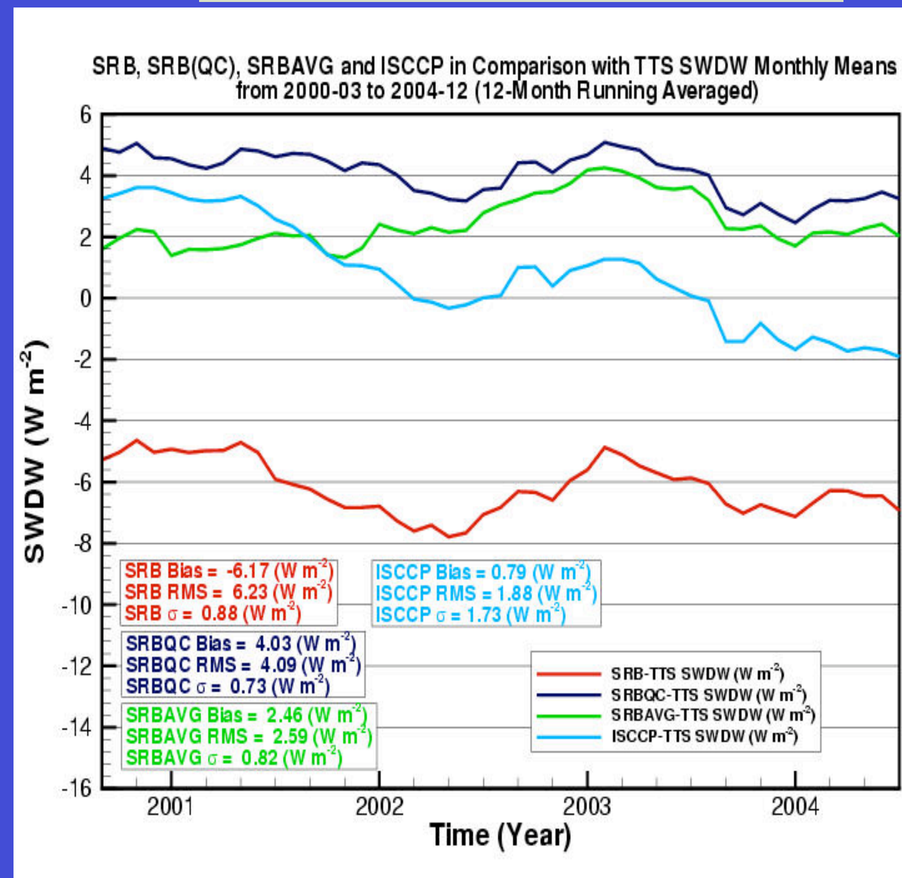
• Courtesy of Stackhouse and Zhang

Comparison of Monthly Surface SW↓ fluxes 12 month running means, (Mar00-Dec04)

Product trendlines



Product - ground site



- Courtesy of Stackhouse and Zhang

Summary of Surface Flux Comparison

- The monthly SRBAVG surface (Model B) regional and ground fluxes are within the bias and RMS errors derived from instantaneous CERES footprint Model B (SOFA) and ground fluxes
  - 3 and 6 year SRBAVG results are very similar
  - SRBAVG surface fluxes show no discernable trends
  - SOFA SW cloudy sky overestimates, clear-sky underestimates
- Some surface stations (a point) may not representative of the 1° region, (coastal, terrain, etc.)

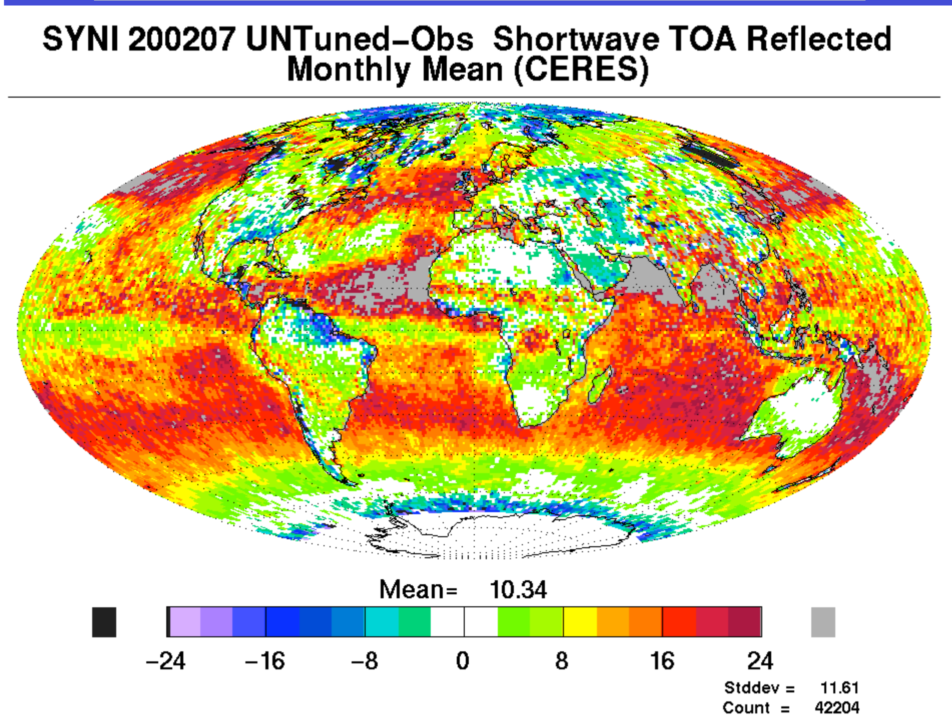
(%)	SW			LW		
	SOFA	SRBAVG		SOFA	SRBAVG	
		Mar00-Feb03	Mar00-Dec05		Mar00-Feb03	Mar00-Dec05
Bias	3.3	3.2	3.6	-0.6	0.0	0.3
RMS	15.0	11.3	11.0	7.4	3.1	3.0

Comparison of GEO BB fluxes with SARB

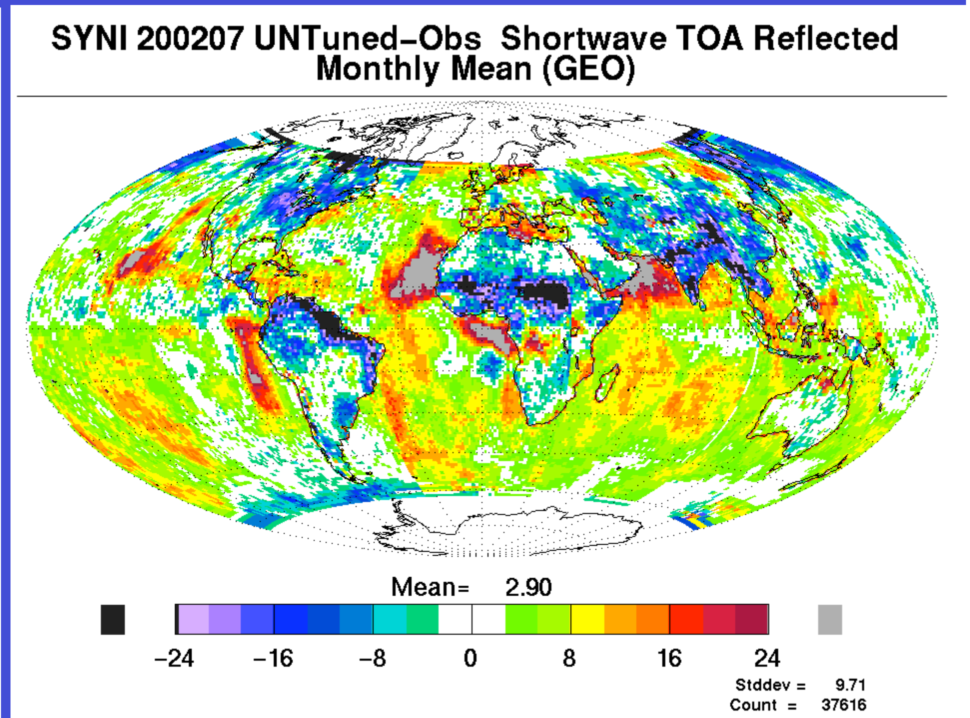
- Purpose
  - To check the consistency between the fluxes and the given cloud property and atmospheric inputs
  - SARB un-tuned flux estimates are from FU-Liou radiative transfer calculations based on input cloud properties and GEOS profiles
- Method
  - Compute SYN for July 2002 globally
  - Compare with CERES fluxes and MODIS cloud properties as a baseline
  - Compare with GEO derived broadband fluxes and GEO cloud properties
    - Errors due to both NB to BB and cloud property errors
- SYNI Beta1 results

Untuned - GEO TOA SW, July 2002

CERES fluxes and clouds



GEO fluxes and clouds

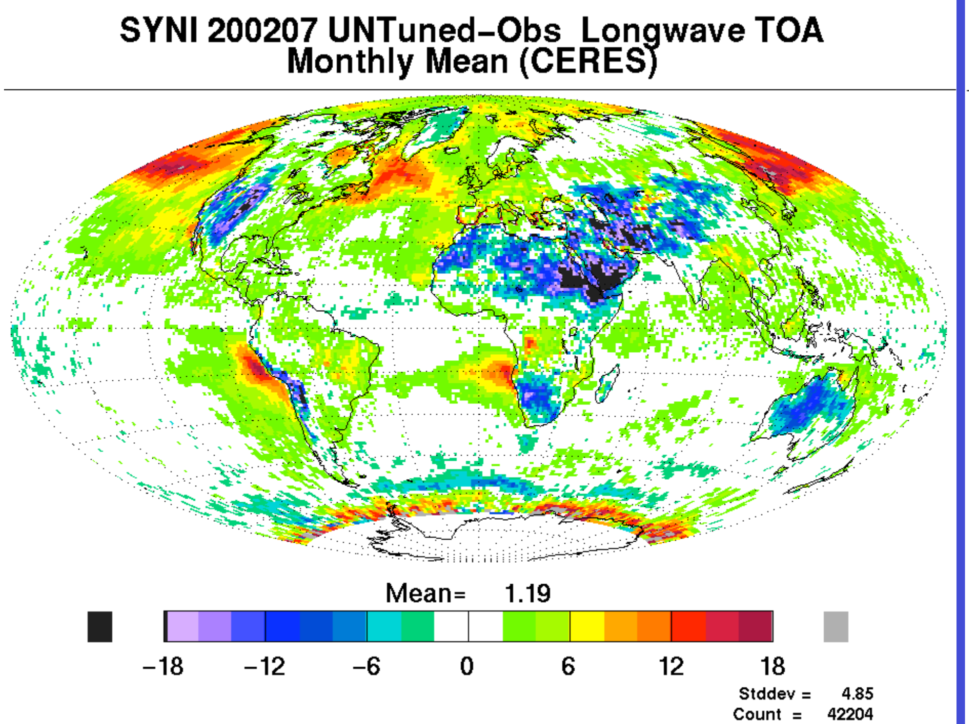


- GEO fluxes and clouds are more consistent than CERES over ocean
- However GEO has greater variability

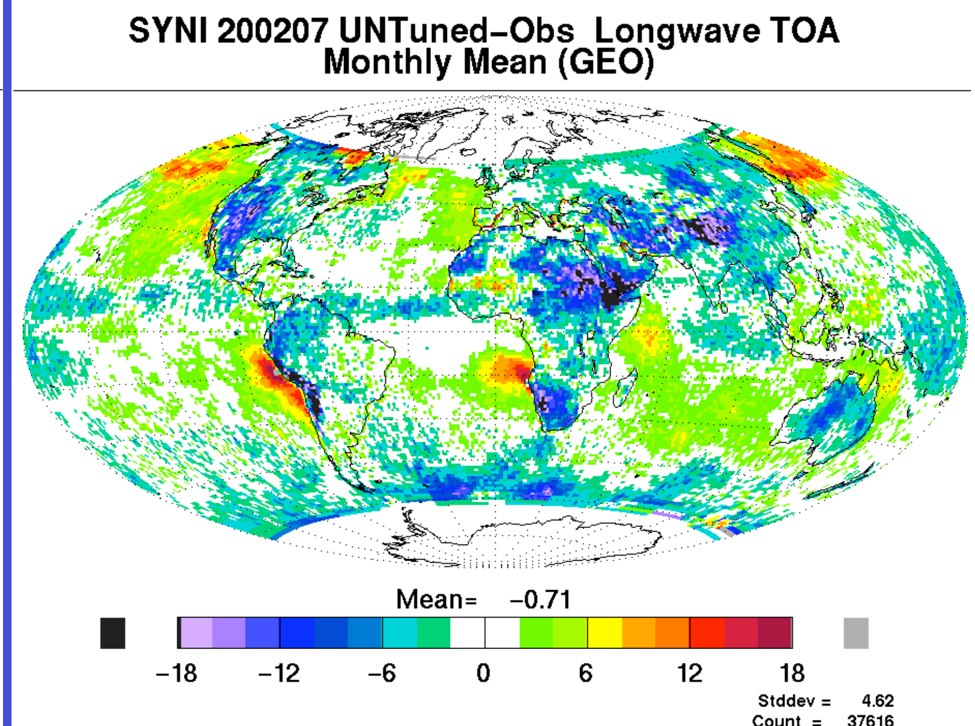
- Courtesy of Fred Rose

Untuned - GEO TOA LW, July 2002

CERES fluxes and clouds



GEO fluxes and clouds



- CERES and GEO fluxes and clouds are consistent
- Same regional patterns shown by Tom Charlock

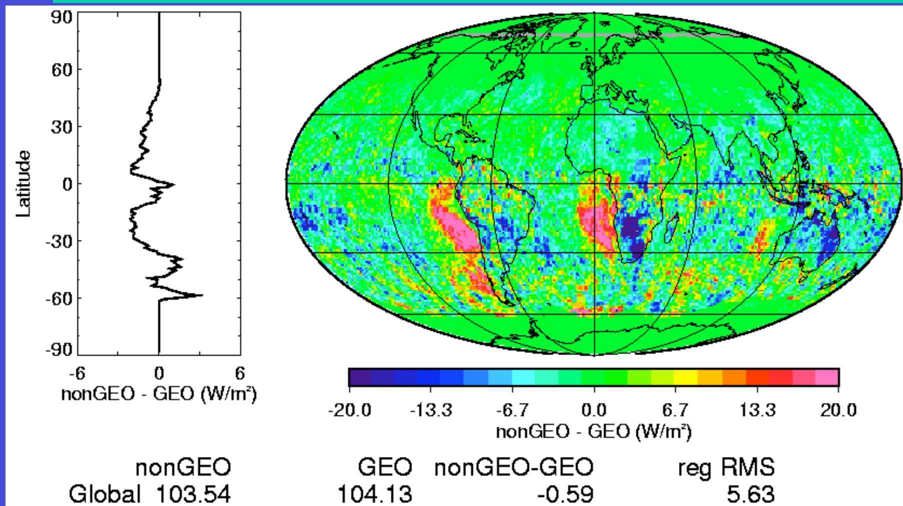
- Courtesy of Fred Rose

Comparison of crosstrack and RAPS SW flux

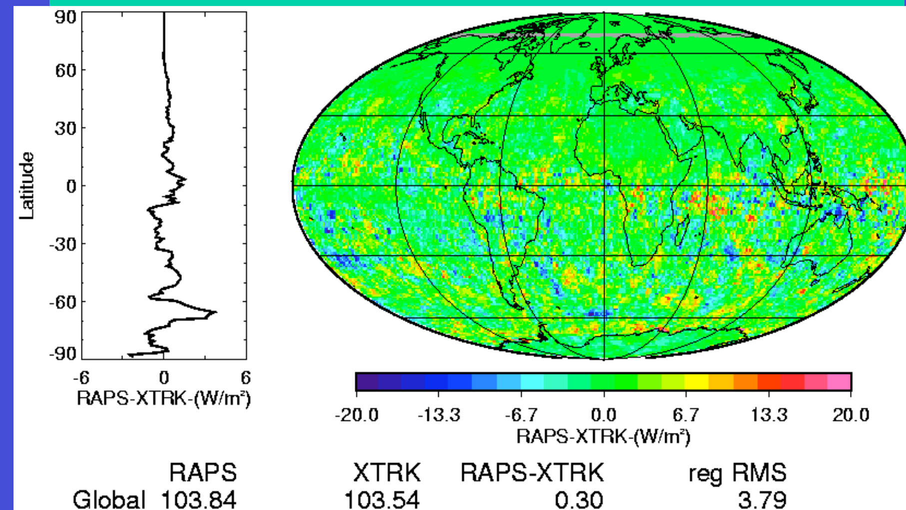
- Purpose
  - How consistent are the monthly means from cross-track and RAPS instrument for the same product?
  - What are the effects of RAPS not completely sampling a 1° region?
  - How well does the SW regional normalization technique work in RAPS mode?
  - Can the CERES instrument calibration differences be observed in the monthly mean products?
- Methodology
  - Compare the nonGEO - GEO fluxes from both crosstrack and RAPS mode
  - Compare the RAPS - crosstrack fluxes from both GEO and nonGEO product
- Error discovered in the SW regional normalization technique in RAPS mode will be corrected for Aqua

SW January 2002

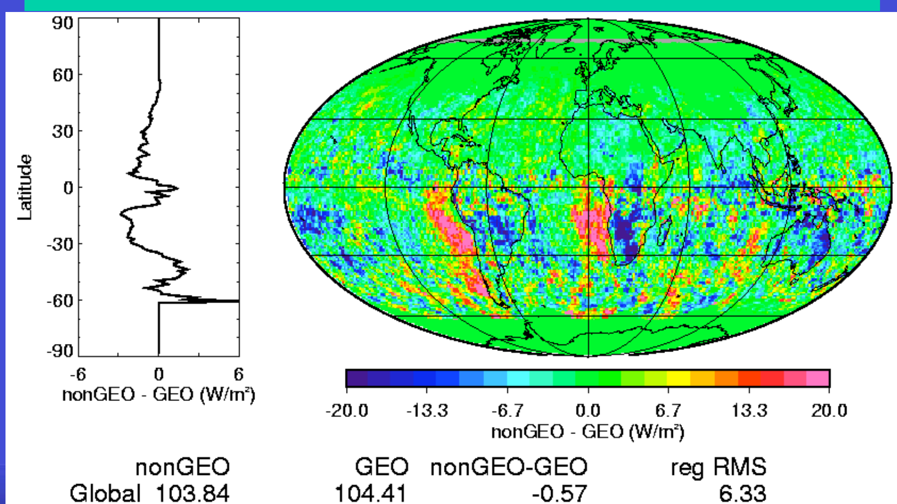
nonGEO - GEO **XTRK**



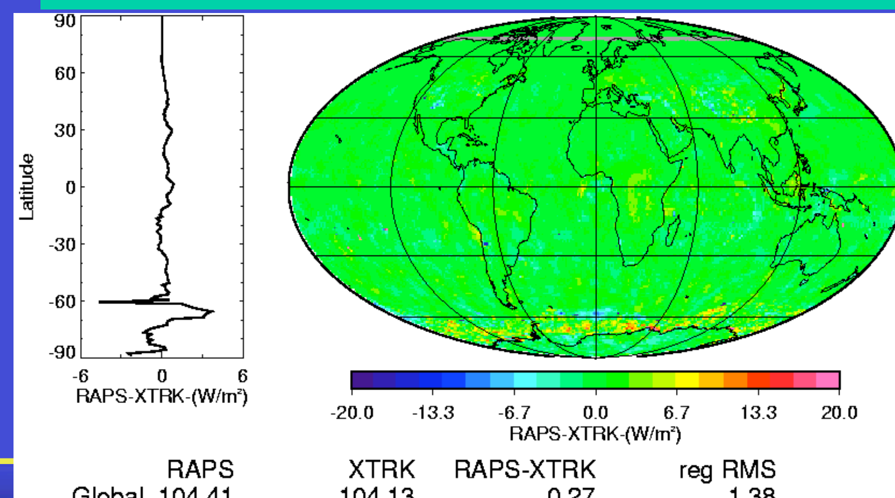
RAPS -XTRK **nonGEO**



nonGEO - GEO **RAPS**



RAPS - XTRK **GEO**



- Note the nonGEO - GEO global flux is consistent between XTRK and RAPS

- Note the reduced RAPS-XTRK RMS of GEO compared with nonGEO

Summary of SRBAVG Ed 2D consistency checks

	SW		LW	
(%)	Bias	RMS	Bias	RMS
Terra-Aqua (instantaneous) (day/night)	0.3 to 0.7	15.0	0.2 to 0.7 -0.5 to –0.3	4.6 4.5
Terra-Aqua (monthly)	1.0	4.2	-0.3	0.9
Surface (monthly)	3.2	11.3	0.0	3.1
SARB (instantaneous)	3.5	14.4	-0.6	5.1
GEO Calibration(monthly)	<0.1	<1.0	<0.1	<1.0
1 vs 3 hourly(monthly)	<0.1	2.5	<0.1	0.4
EOF	No GEO artifacts			
GEO directional	Consistent with CERES			

- All biases are < 1% or consistent with CERES fluxes (SW SARB and Surface)

5 Year Global Mean TOA Fluxes Mar00-Feb05

Wm-2	1986-1988	CERES Mar00 – Feb03		
All-Sky	ERBE	ERBE-like	nonGEO	GEO
OLR	236.3	239.0	237.7	237.1
SW	101.1	98.3	96.6	97.7
NET	4.9	4.0	7.0	6.5

ADM improvement — Diurnal improvement

- Net imbalance within envelope of systematic errors of ocean heat storage, Solar constant and SW reflected flux - to be addressed by Norm Loeb
- 3,4,and 5 year annual means are very similar (mainly within 0.1 Wm^{-2})

3-Year Multi-Dataset TOA Flux Comparison

Observed

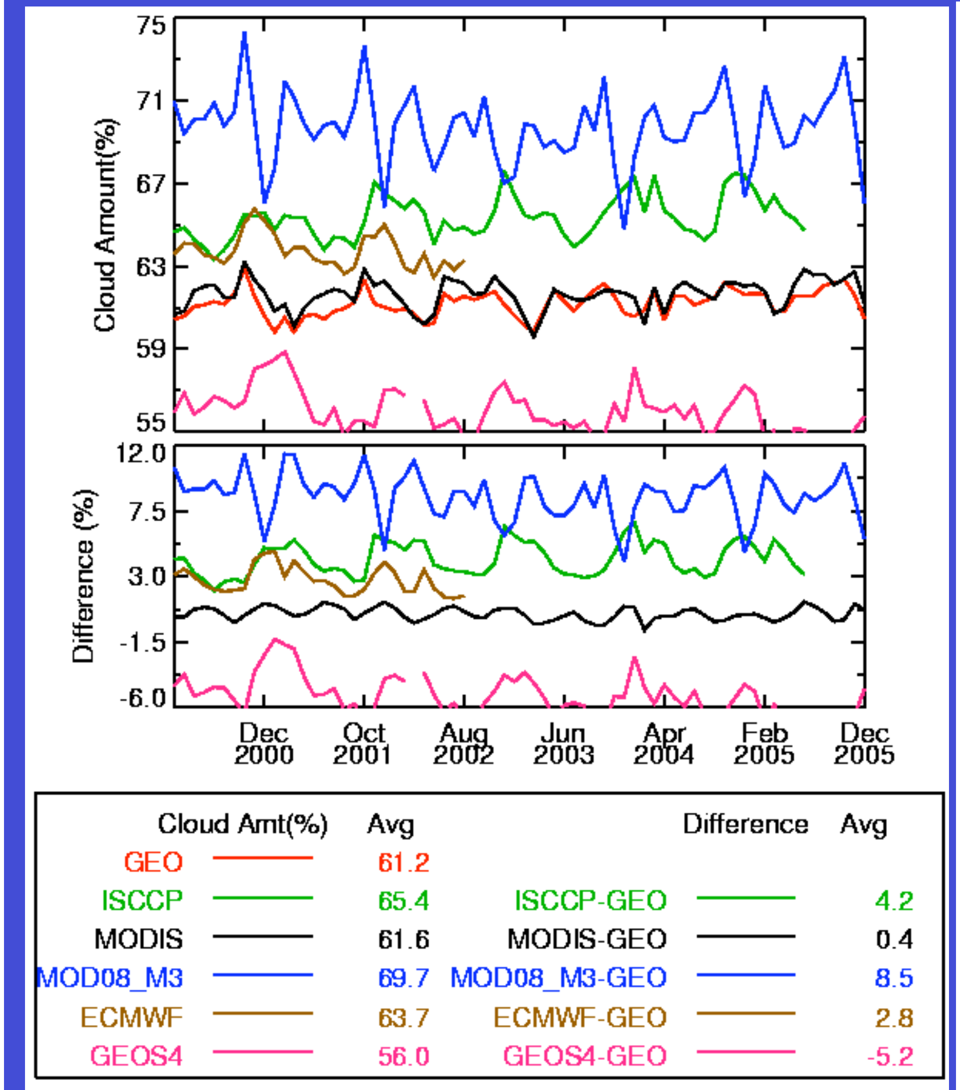
PROJECT	CLOUDS	PROFILE	FLUXES
CERES-ERBElike			measured
CERES-nonGEO	*MODIS*		measured
CERES-GEO	*MODIS+GEO*	*GEOS*	measured
CERES-SARB	MODIS+GEO	GEOS	Fu-Liou
SRB	ISCCP obs	GEOS	Fu-Liou
ISCCP-FD	ISCCP obs	TOVS	
GEOS-4	Modeled	GEOS	Chou
NCEP-reanalysis	Modeled	NCEP	
ECMWF-ERA40	Modeled		

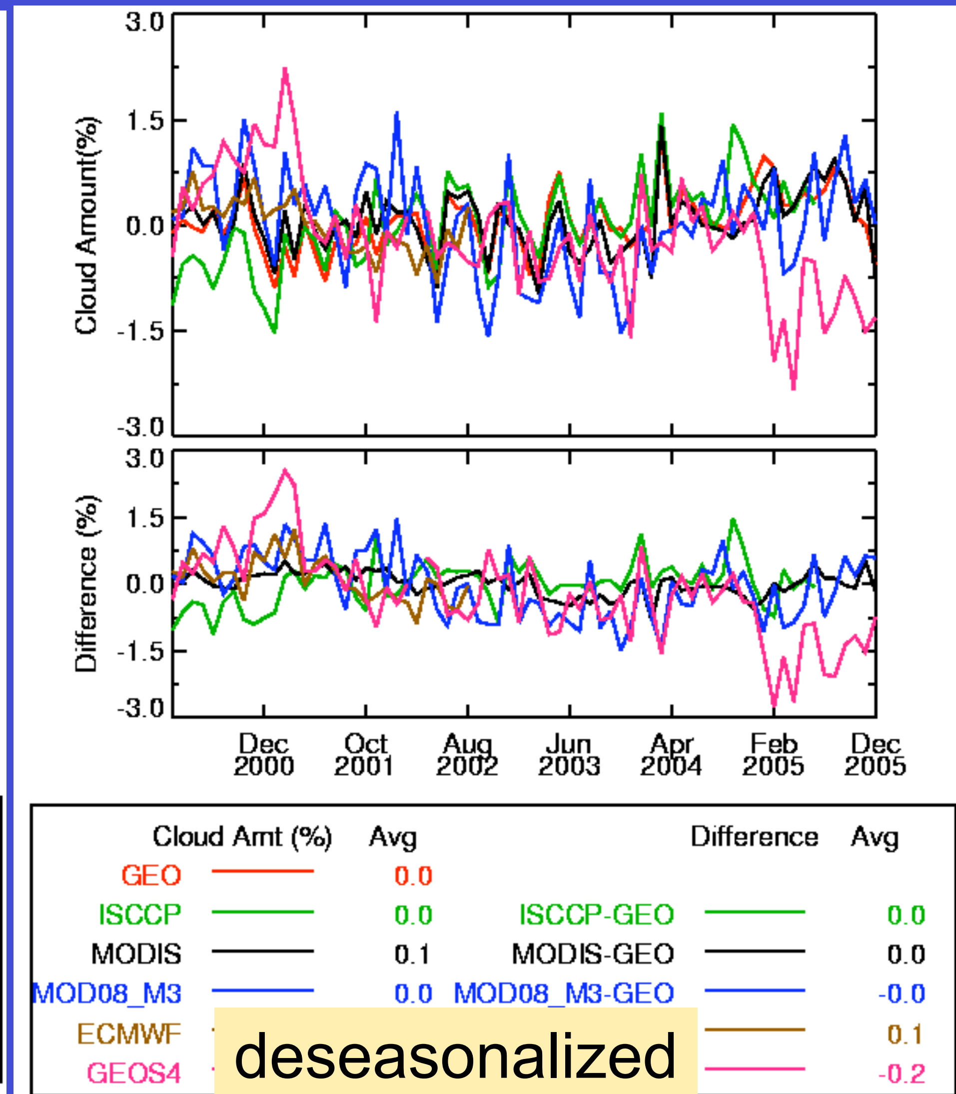
Modeled

TOA global 5-year flux means (Mar00-Feb05)

Wm-2	CERES ES-4 ERBE-like	CERES SRBAVG non-GEO	CERES SRBAVG GEO	SRB GEWEX	ISCCP FD	NCEP REANAL-YSIS	GEOS4
$OLR_{ALL-SKY}$	239.0	237.7	237.1	240.6	235.8	238.6	250.4
$SW_{ALL-SKY}$	98.3	96.6	97.7	101.2	105.2	117.2	92.4
$NET_{ALL-SKY}$	4.0	7.0	6.5	-2.5	0.5	-11.6	-1.0
$OLR_{CLEAR-SKY}$	266.6	266.4	264.1	268.1	262.3	270.3	271.5
$SW_{CLEAR-SKY}$	49.3	51.2	51.1	53.5	54.2	54.8	47.1
$NET_{CLEAR-SKY}$	25.4	23.7	26.2	17.7	25.0	19.1	23.1
$OLR_{CLOUD-FORCING}$	27.6	28.7	27.0	27.5	26.5	31.7	21.1
$SW_{CLOUD-FORCING}$	-49.0	-45.4	-46.6	-47.7	-51.0	-62.4	-45.3
$NET_{CLOUD-FORCING}$	-21.4	-16.7	-19.7	-20.2	-24.5	-30.7	-24.1

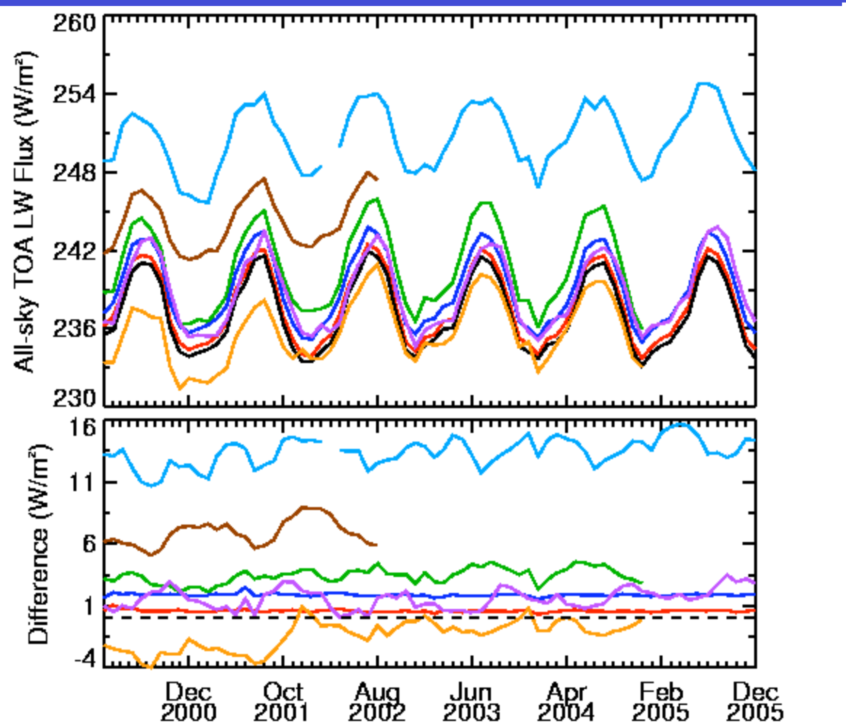
Global Cloud Amount Mar00-Dec05

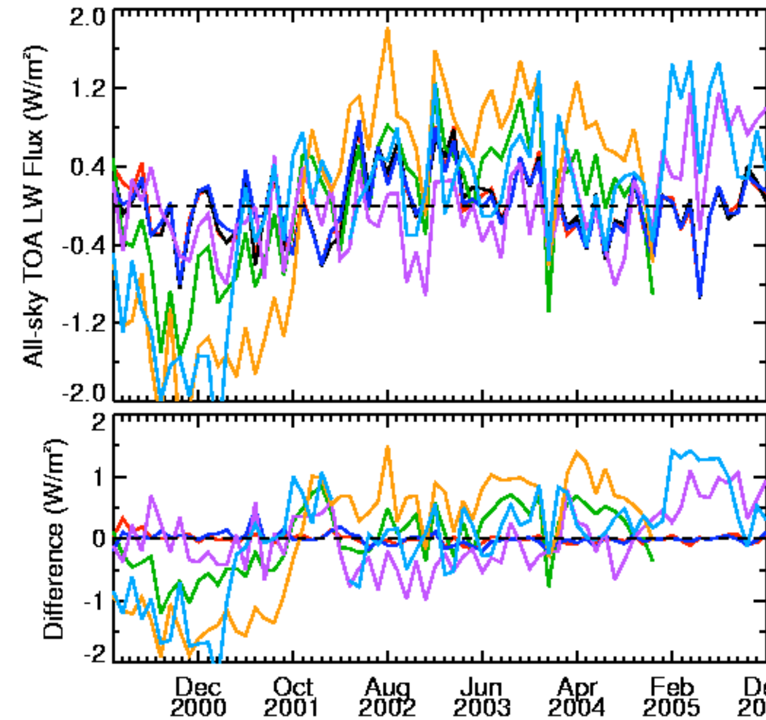




- Validates GEO calibration, cloud properties not normalized to MODIS

Global TOA LW flux Mar00-Dec05





All-sky TOA LW		Difference	Avg
nonGEO	237.8	nonGEO - GEO	0.6
GEO	237.2		
SRB	240.6	SRB - GEO	3.4
ERBE_like	239.1	ERBE_like - GEO	1.9
NCEP	238.8	NCEP - GEO	1.6
ECMWF	244.3	ECMWF - GEO	6.9
ISCCP FD	235.8	ISCCP FD - GEO	-1.4
GEOS4	250.6	GEOS4 - GEO	13.4

All-sky TOA LW		Difference	Avg
nonGEO	0.0000	nonGEO - GEO	0.0000
GEO	0.0000		
SRB	-0.0000	SRB - GEO	-0.0068
ERBE_like	0.0000	ERBE_like - GEO	0.0000
NCEP	-0.0000	NCEP - GEO	-0.0000
ISCCP FD			-0.0068
GEOS4			-0.0048

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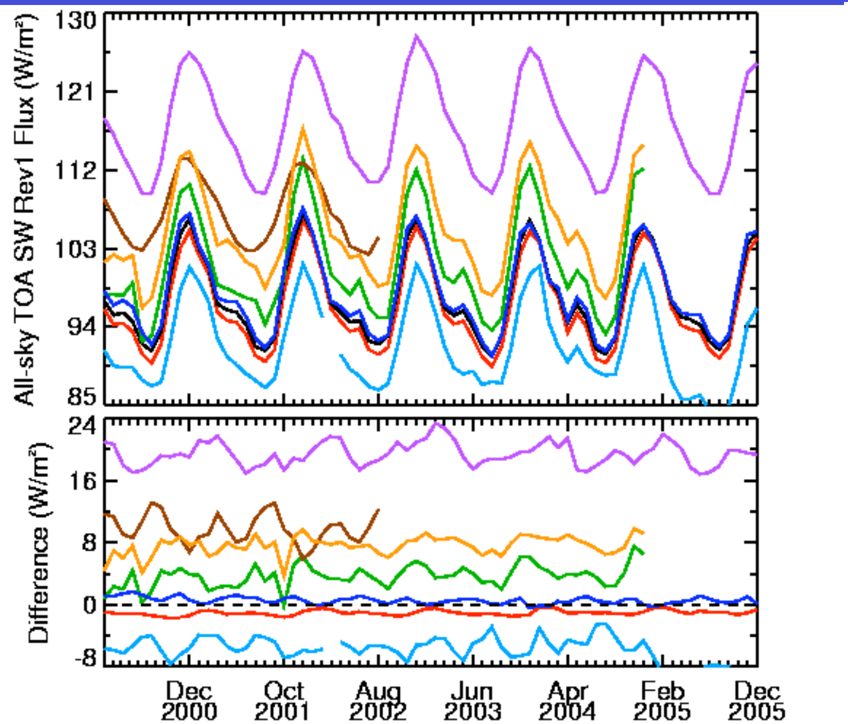
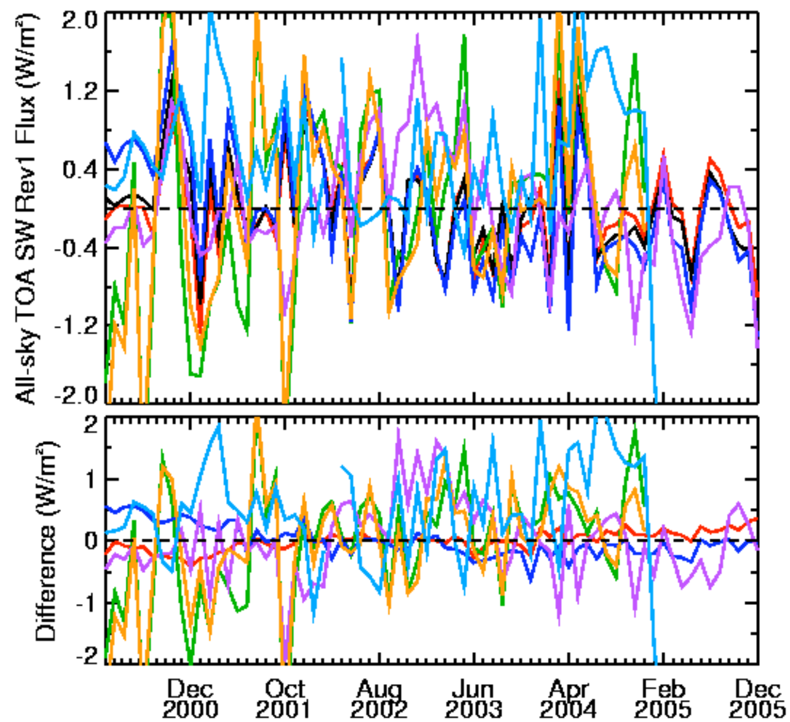
NASA Langley Research Center / Atmospheric Sciences

Global TOA SW flux Mar00-Dec05





All-sky TOA SW Rev1		Difference	Avg
nonGEO	96.5	nonGEO - GEO	-1.0
GEO	97.5		
SRB	101.2	SRB - GEO	3.7
ERBE_like	98.1	ERBE_like - GEO	0.6
NCEP	117.0	NCEP - GEO	19.4
ECMWF	107.0	ECMWF - GEO	9.8
ISCCP FD	105.2	ISCCP FD - GEO	7.6
GEOS4	91.7	GEOS4 - GEO	-5.8

All-sky TOA SW Rev1		Difference	Avg
nonGEO	-0.0000	nonGEO - GEO	0.0000
GEO	-0.0000		
SRB	0.0000	SRB - GEO	-0.0427
ERBE_like	0.0000	ERBE_like - GEO	0.0000
NCEP	0.0000	NCEP - GEO	0.0000
ISCCP FD			-0.0427
GEOS4			-0.0022

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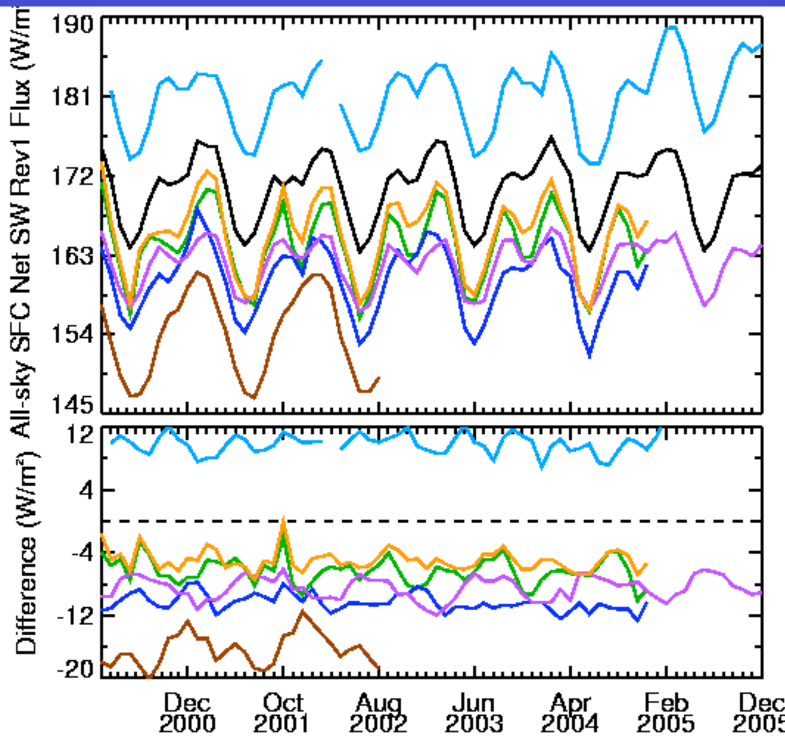
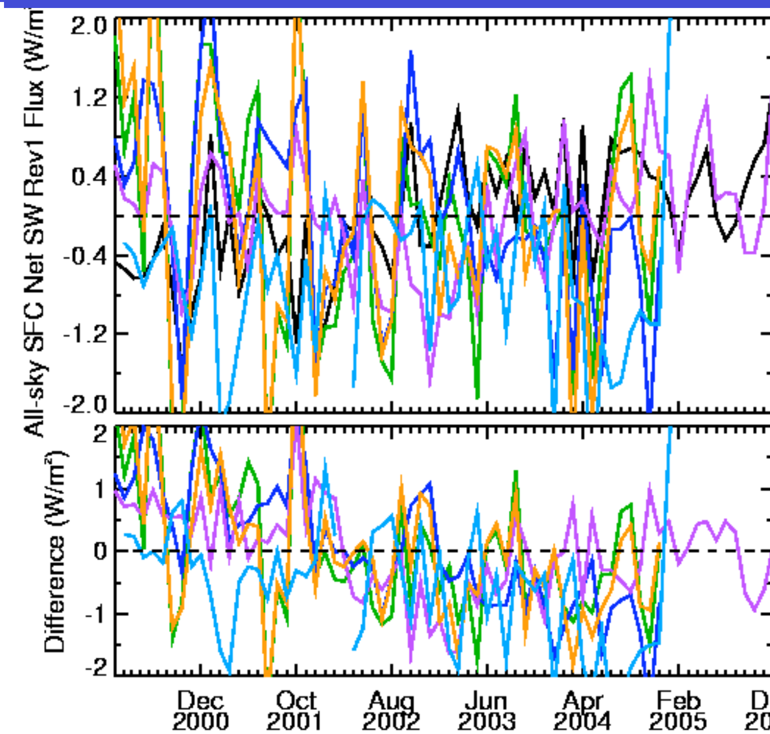
- Concerned about a 0.1 Wm-2/year nonGEO-GEO trend

Global SFC Net SW flux Mar00-Dec05





All-sky SFC Net SW Rev1		Difference	Avg
modelA		modelA - modelB	
modelB	170.6		
SRB	164.2	SRB - modelB	-6.3
SRB_QC	160.2	SRB_QC - modelB	-10.4
NCEP	162.1	NCEP - modelB	-8.5
ECMWF	153.8	ECMWF - modelB	-16.3
ISCCP FD	165.6	ISCCP FD - modelB	-5.0
GEOS4	180.9	GEOS4 - modelB	10.5

All-sky SFC Net SW Rev1		Difference	Avg
modelA		modelA - modelB	
modelB	0.0		
SRB	0.0	SRB - modelB	0.1
RB_QC	0.0	SRB_QC - modelB	0.1
NCEP	-0.0	NCEP - modelB	-0.0
ECMWF		ECMWF - modelB	
CCP FD			0.1
GEOS4			-0.0

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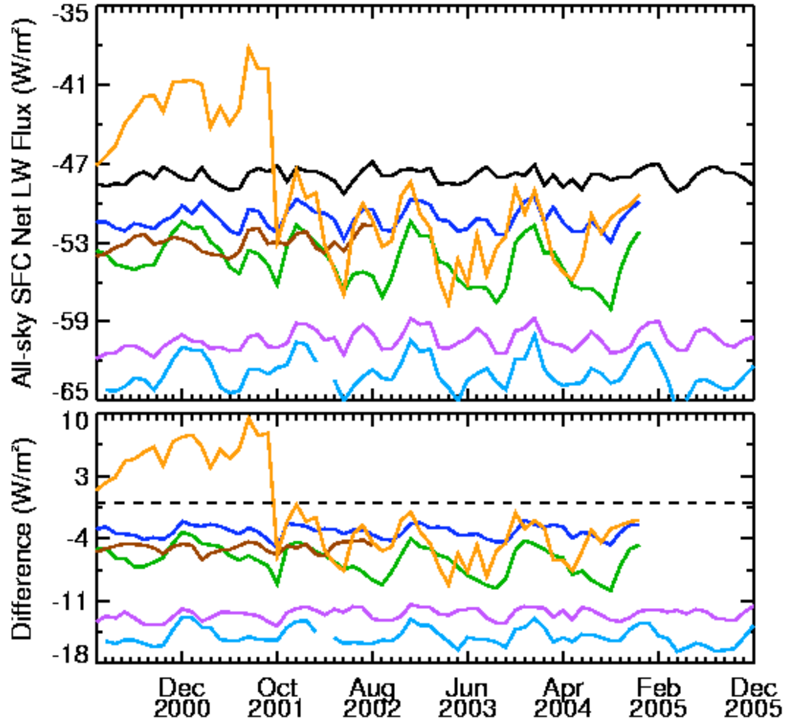
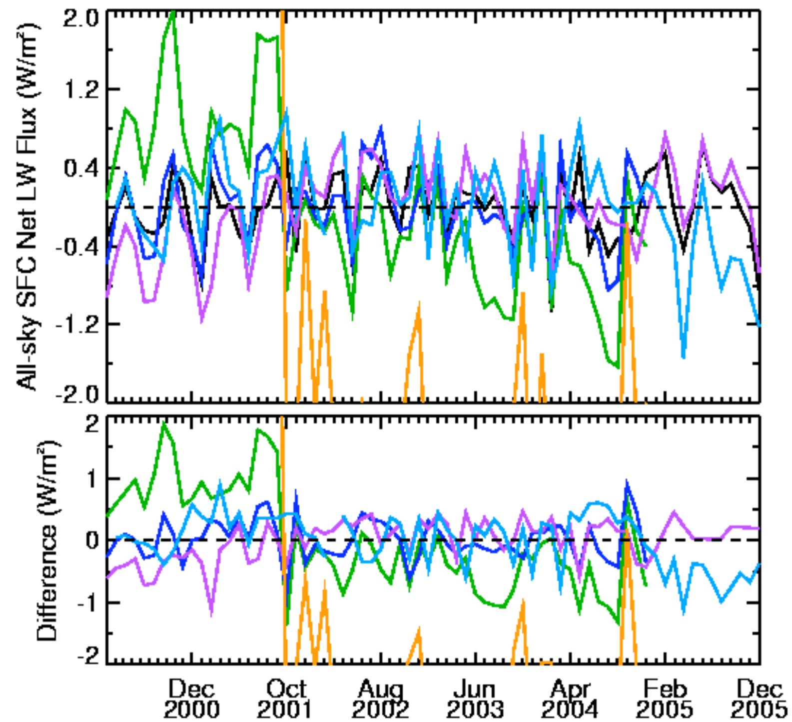
Global SFC Net LW flux Mar00-Dec05





All-sky SFC Net LW		Difference	Avg
modelA		modelA - modelB	
modelB	-48.0		
SRB	-54.4	SRB - modelB	-6.4
SRB_QC	-51.2	SRB_QC - modelB	-3.2
NCEP	-60.4	NCEP - modelB	-12.5
ECMWF	-53.0	ECMWF - modelB	-5.0
ISCCP FD	-49.0	ISCCP FD - modelB	-1.1
GEOS4	-62.9	GEOS4 - modelB	-15.0

All-sky SFC Net LW		Difference	Avg
modelA		modelA - modelB	
modelB	0.0		
SRB	-0.0	SRB - modelB	0.0
SRB_QC	0.0	SRB_QC - modelB	0.0
NCEP	-0.0	NCEP - modelB	-0.0
ECMWF		ECMWF - modelB	
ISCCP FD			0.0
GEOS4			0.0

deseasonalized

Conclusions

- The CERES GEO product represents a major improvement over currently available global Earth energy budget datasets

- Incorporates CERES ADMs and MODIS scene identification to derive fluxes
- Uses geostationary derived fluxes to temporally interpolate between CERES measurements
  - GEO derived fluxes have been normalized with CERES to ensure unbiased fluxes with respect to region, cloud amount, SZA and VZA and geostationary calibration changes
  - GEO derived fluxes have been rigorously validated, <1% bias

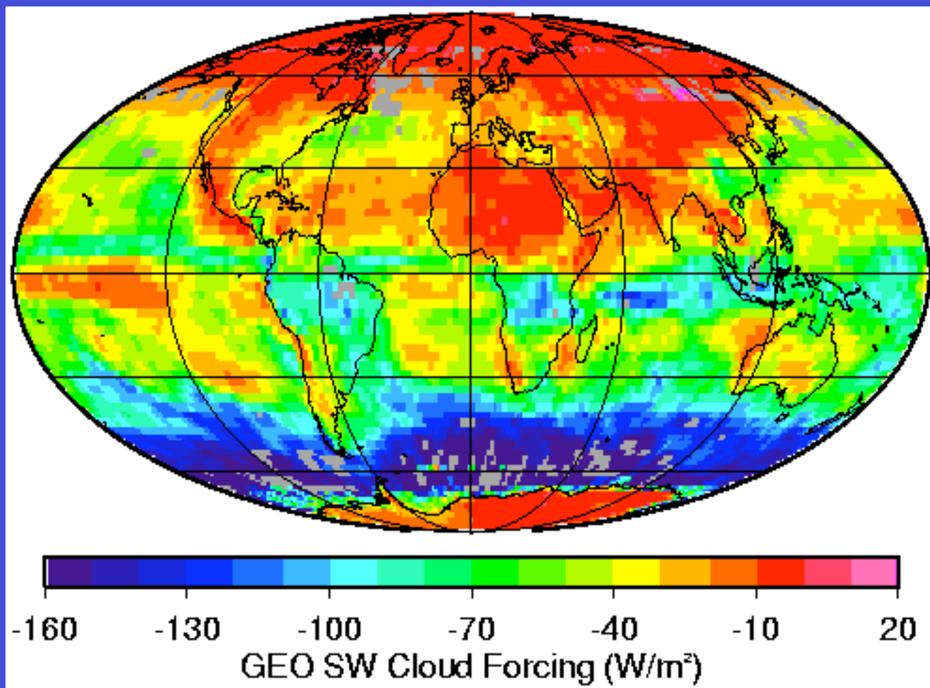
- GEO - nonGEO (Terra 10:30LT sampling) SW and LW monthly global flux difference is 1.1 Wm^{-2} and -0.6 Wm^{-2} respectively
  - Monthly regional SW differences can be > 20 Wm^{-2} ,Monthly hourly > 100 Wm^{-2}

- Mar00-May04 Terra GEO product currently available

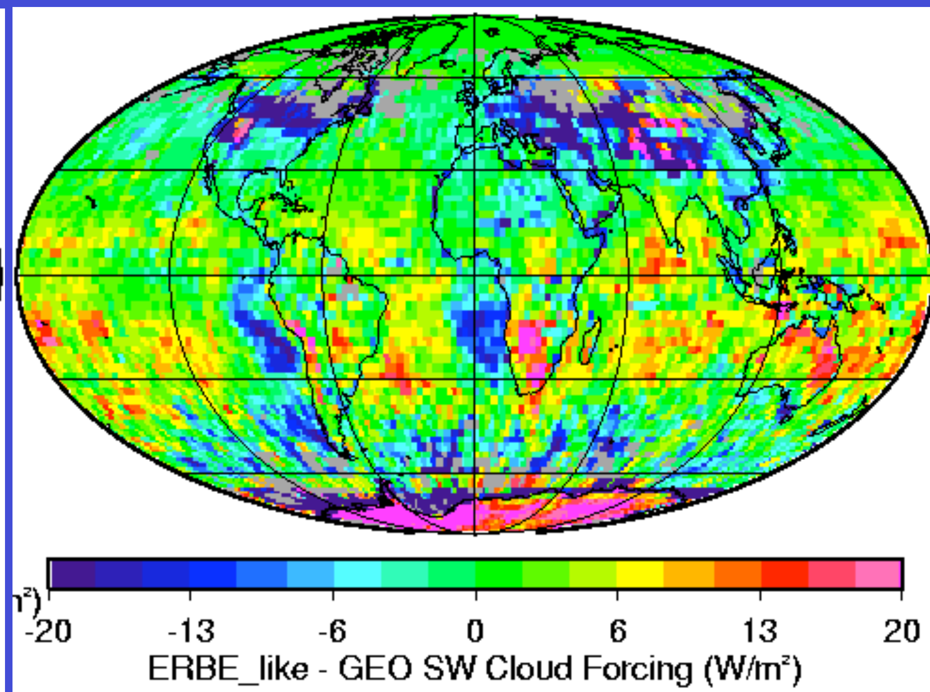
Backup slides

TOA SW Cloud Forcing, Jan 2002

SRBAVG-GEO



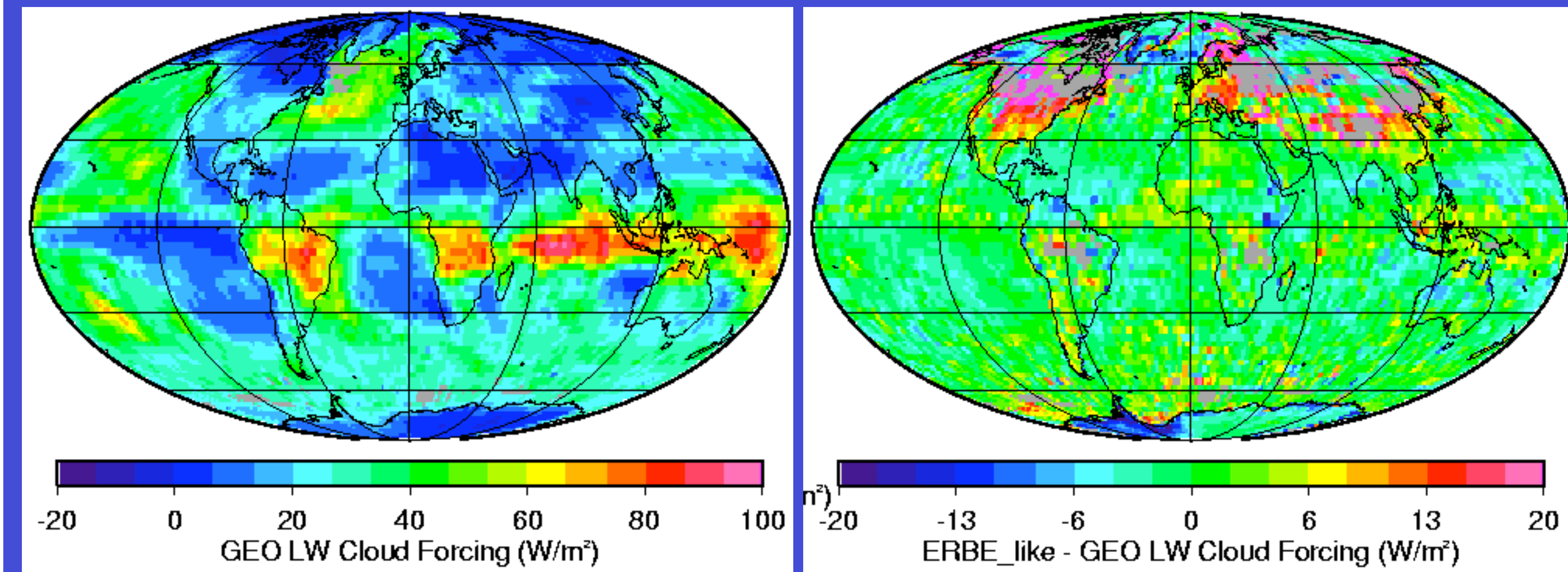
ERBE_like - SRBAVG_GEO



- $SW_{CF} = SW_{clear\text{-}sky} - SW_{all\text{-}sky}$ Blue is cooling, Red is warming

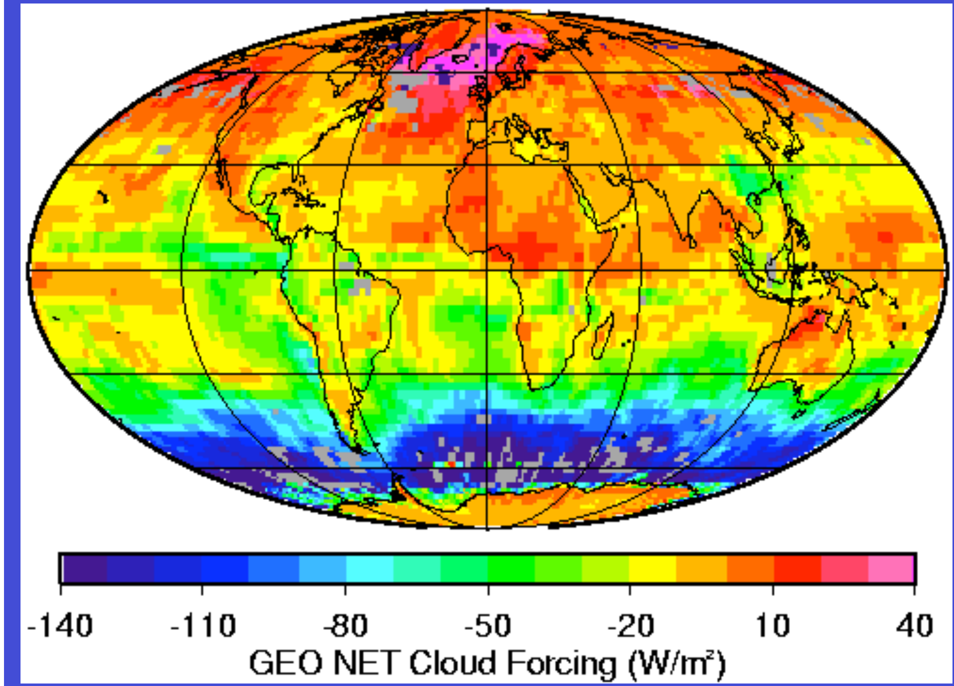
TOA LW Cloud Forcing, Jan 2002

SRBAVG-GEO | ERBE_like - SRBAVG_GEO



TOA NET Cloud Forcing, Jan 2002

SRBAVG-GEO



ERBE_like - SRBAVG_GEO